국제학석사학위논문

The Skill Biased Impact of Global Value Chain Participation on Wages in Korea:

Evidence from Trade in Value Added and KLIPS Panel Data

글로벌 가치사슬 참여가 한국 노동자의 임금에 차별적으로 미치는 숙련편향적 효과:

부가가치 무역과 KLIPS 패널 데이터 기반의 실증 분석

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조 경 모

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The Skill Biased Impact of Global Value Chain Participation on Wages in Korea:

Evidence from Trade in Value Added and KLIPS Panel Data

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글로벌 가치사슬 참여가 한국 노동자의 임금에 차별적으로 미치는 숙련편향적 효과: 부가가치 무역과 KLIPS 패널 데이터 기반의 실증 분석

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Abstract

The main objective of this study is to elucidate how exposure to globalization in the form of participation in global value chains (GVCs), or the fragmentation of different stages of production across national and regional borders, has affected the wages of workers with different skill levels in the labor market of South Korea. The rise of income inequality within many developed and developing countries has once again captured the interest of academia, the public, and politicians. It has long been known that inequality affects political stability and social cohesion. Nowadays, political tensions run high in many nations, and as can be seen from various social phenomena such as the rise of populism, civil protests, and protectionism in the form of an ongoing trade war between the world's two largest economies, the U.S. and China, the potential relationship between globalization and inequality continues to have ever more serious political implications. However, the costs of trade barriers such as tariffs, quotas, and other non-tariff barriers such as import or export restrictions are now higher than ever, due to the importance of cross-border supply chain trade that links international production networks. In an era of GVCs, tariffs are escalated because inputs must cross borders multiple times, while production and employment in many seemingly domestic-oriented industries such as agriculture and services actually depend on foreign markets, because their value-added is indirectly embodied as inputs in manufactured exports. Thus, trade restrictions may lead to significantly greater negative impacts on wages and employment than in previous eras. Moreover, barriers aimed bilaterally at one country can affect numerous other countries that participate in production sharing. In light of the high costs of protectionism in the contemporary world, an examination of whether trade actually has adverse distributional effects is crucial. Until the 1980s and early 90s, the consensus of neoclassical economists was that trade only had a minor impact on inequality while skill-biased technical or technological change and other factors were far more important drivers of divergences in the income of high and low skilled workers. Nevertheless, public suspicion and concern over the relationship has been unabated, and

more recent literature on the relationship between offshoring and income inequality has shown conflicting results. At the same time, the expansion of global value chains and fragmentation of production increases the importance of studying the potential effects of a skill bias in trade with new GVC and value added trade indicators, since nowadays foreign intermediate goods and services are significantly embodied in the final product exports of a country, unlike the age of David Ricardo or Adam Smith, when exports were only domestically produced. Empirical findings regarding the relation between GVC participation and its distributional impacts on labor have been mixed, furthering the case for continued empirical investigation.

The case of Korea, one of the most heavily integrated developed countries in GVCs, is also important because many economists have suggested that more investment in the tertiary education of unskilled workers can alleviate income inequality, but Korea has been experiencing a rise in inequality in spite of having the largest proportion of high skilled workers among OECD countries when following ISCED classifications. As such, a careful examination of how GVCs affect wage inequality can provide useful insights for developing countries that want to consistently upgrade their industries akin to the path that Korea has followed. Likewise, Korea's case has important implications for developed nations: Korea is an outlier among developed nations because it has a remarkably robust manufacturing sector as compared to services, yet, the existence of a skill bias of global supply chain trade in spite of this may imply that current high income economies tempted to engage in protectionism to "re-shore" overseas production back into national borders (such as the U.S.) might not achieve the distributional results they intended. The lower value-added assembly stages of manufacturing coming back would not necessarily contribute to reducing inequality in the home country. A careful examination of the literature on the labor market impacts of international production sharing, as well as the qualitative characteristics of Korea's offshoring, GVC-related trade, foreign direct investment, and development - industrial upgrading trajectory are factored into the formulation of several hypotheses on how heterogeneous types of GVC

participation might impact workers of different skills in Korea. This is to complement the limitations of value added trade data in showing the composition of business functions as well as direction of industrial upgrading, as finding the specific mix of tasks and skills embodied in GVC trade is crucial to understanding labor market impacts.

To test these hypotheses, a panel data set consisting of 7,689 individuals and 31,974 individual-year observations is constructed by merging and matching data from the Korea Labor Income Panel Survey (KLIPS) with the updated 2018 version of the Organisation for Economic Co-operation and Development (OECD) – World Trade Organization (WTO) Trade in Value Added (TiVA) indicators, which are derived from the Inter-Country Input-Output (ICIO) database. This empirical model links the 36 industry-level indicators of TiVA, which covers 64 economies for 2005-2015, with the micro-individual level data of Korean workers from 2009-2017. The skill level of labor, measured in terms of educational attainment, is interacted with three different types of GVC participation indices (total, forward, and backward) of the respective industries in which the workers are employed each year. The wages of each individual worker, the dependent variable, are regressed on this product term of skills and GVC participation, using a variation of the Mincerian human capital wage equation along with various controls and fixed effects appropriate for this multi-dimensional panel data analysis. This approach of investigating the relationship between industry-level cross-border production sharing indicators on individual-level variables has a significant methodological advantage compared to many earlier studies using industry-level wage variables. Combining the two different levels can mitigate endogeneity concerns that may arise due to simultaneity bias.

Overall, the findings of this study show that differences in GVC integration at the industry level indeed have heterogeneous effects on wages of individual workers classified in different skill groups. While all three types of GVC participation have positive effects on wages when controlling for other variables, the direction and magnitude of coefficients for each group of workers suggests the existence of a “skill-

bias," in which increased GVC participation has a relatively favorable impact toward higher skilled employees as opposed to low or mid-skilled workers. This skill-bias is strongest for forward participation, which underlines the importance of distinguishing between different types of GVC participation, a factor which was neglected in previous empirical studies combining sector-level GVC indicators with individual-level labor data. The fact that these results directly contrast with a recent cross-country study that found skill-biased effects for backward GVC trade rather than forward supply chain linkages, suggests that the country-specific business functions, skills, and tasks embodied within intermediate inputs trade affect the causal relationship between both types of GVC participation and labor market impacts, in line with this dissertation's analysis of Korea's specific position in GVC trade and development trajectory.

Moreover, robustness checks show that the results are generally stable when estimated with complementary or alternative specifications of variables and models, including time lags and the Value Added Exports (VAX) ratio. At the same time, although there is a skill bias of global supply chain trade, this research shows that overall wages of workers are positively affected through all types of GVC trade, hence leading to the suggestion that the current protectionist sentiment spreading in the global economy is not the optimal answer to deal with inequality. Although the study mostly draws insights from and fills in the gap in contemporary international trade literature and labor economics, the multi-disciplinary relevance of the findings with respect to global value chains and within-country income inequality should be of interest to scholars and policy-makers of many fields, including, but not restricted to, political science, international relations, political economy, sociology, educational studies, public policy, and business management.

Keywords: global value chains; international trade in value added; offshoring jobs and tasks; labor market wage inequality; panel data analysis; skills and education premium; vertical specialization

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I. INTRODUCTION

1. Background and Research Motivation

The world has experienced a major backlash against globalization in the form of an ongoing trade war between the United States of America (henceforth referred to as the U.S.) and China, which are the world's two largest economies. Mounting public concern and suspicion over the role that international trade, foreign outsourcing, vertical and horizontal foreign direct investment (FDI), as well as other aspects of globalization may have had in exacerbating inequality and unemployment *within* countries[1] has led to populist sentiment pressuring governments to deal with deindustrialization, or the "hollowing-out" of the manufacturing sector in major developed economies. Hyperglobalization has been closely tied to the proliferation of *global value chains*, or the international fragmentation of production[2] across many country borders. In an age of global value chains (GVCs), many products and services are "Made in the World", rather than in one country (Antràs, 2016:4). Various countries contribute some value-added in different stages of production, and this production sharing is linked together by trade in intermediate goods and services. Trade in intermediate inputs has grown 4.5

[1] Contrary to public perception, *global* inequality *between* different countries at the international level has been falling in contrast with country-specific *within* inequality, partly due to globalization lifting many people in developing countries out of poverty (see Lopez-Gonzalez, Kowalski, and Achard (2015:21); Feenstra (2016:33); UNCTAD, 2013:148) among others

[2] A detailed overview on the various synonyms that have been used to describe global value chains is provided in the second chapter to this thesis.

times faster than traditional trade between 1990-2015, while recent estimates suggest GVC-related trade now accounts for 70% of global intermediate inputs trade (Dollar, 2019; OECD, 2018b; Ruta, 2017:175). The key underlying causes behind the expansion of global supply chains has been a rapid decrease in communication and transportation costs, as well as a liberal trade environment after the end of the Cold War, with falling trade barriers in most countries through multilateral trade negotiations such as the Uruguay Round as well as preferential or free trade agreements (FTAs). Because the prevalence of GVC trade means that countries increasingly import foreign value added or overseas intermediate inputs to be used in their exports, trade statistics change dramatically when measured in value added terms instead of traditional gross terms. Traditional gross statistics exaggerate the exports of countries at the end of value chains such as China, which imports numerous intermediate inputs for assembly and then re-exports many final products, For example, the bilateral trade deficit which the U.S. has against China drops by about 50% when measured through value added exports (Dollar, 2019:2). However, reliable value-added trade data estimates have only very recently become available, meaning that much of economic analysis on trade has and still continues to rely on conventional trade statistics.

The expansion of GVCs has contributed to improving growth and productivity in many countries, facilitating industrial upgrading in developing countries such as Vietnam (Dollar, 2019:3). Structural transformation from GVC participation allows workers, including women, to move to better-paying occupations and fosters the

development of backward linkages that benefit not just exporting firms, but domestic companies that supply inputs to the exporters (*ibid.*). Advanced economies have also seen gains at the aggregate level. Nevertheless, some recent studies suggest that GVC participation may indeed have skill-biased distributional impacts, that is, benefiting high-skilled workers at the expense of lower-skilled labor (Bacchetta and Stolzenburg, 2019; Hollweg, 2019). Unfortunately, both the theoretical and empirical economic literature suggest that protectionism is not the answer to solving these issues. In fact, when GVCs are prevalent, the cost of protectionism becomes amplified through tariff accumulation. Rising trade costs in GVCs leads to a so-called "cascade effect": firms in both upstream and downstream stages of production must repeatedly pay tariffs on the imported intermediate goods in each stage of production (Diakantoni *et al.*, 2017). Moreover, as countries specialize in these different stages of production, individuals and firms that perform tasks in traditionally *domestic-oriented* industries such as agriculture (Greenville *et al.*, 2019) or services are increasingly *indirectly* exporting their value added to other countries, since the output they create are used as crucial inputs in cross-border supply chains. Productivity growth in industries highly integrated with GVCs has a spillover effect to supplying, domestic industries. This means that GVCs generate jobs not only for direct exporters, but also to domestic suppliers of inputs through newly fostered backward linkages (Dollar, 2019:3). For instance, a study by the OECD (2016) found that there were more jobs "indirectly" involved in exports than in the direct exporters.

The OECD (2019) estimates that GVC-related trade now accounts for between 20-26% of total agricultural labor force income, although this differs widely depending on the industry and country in question.[3] This is because agriculture exports now use significant goods and services inputs such as fertilizers, R&D, and knowledge of farm technicians to generate more value-added (*ibid.*). To illustrate, some global agricultural cooperatives have transformed into global multinational companies (MNCs) that coordinate agriculture GVCs. One example is New Zealand agriculture cooperative Zespri, which focuses on R&D activities to develop better varieties of species of Gold Kiwi with higher sugar content and stronger immunity against pests, and then supplies these varieties to Korea, China, Spain, and Germany. As a lead firm in agro-food GVCs, Zespri engages in contract farming and provides customized consulting to farms in various regions around the world including in Jeju Island of Korea, managing the entire value chain and transferring technology to ensure quality control and rational pricing.[4] Not only do GVCs influence agriculture productivity through the presence of agro-food chains, but they also imply that agricultural output can be used as inputs in manufacturing GVCs, affecting costs and productivity in other sectors. The OECD utilizes the METRO Model to demonstrate that in a hypothetical scenario of decreased trade barriers in agriculture, spillover effects carry on to the manufacturing sector, resulting in lower costs and higher domestic output in all industries (see **Figure 1.1** on

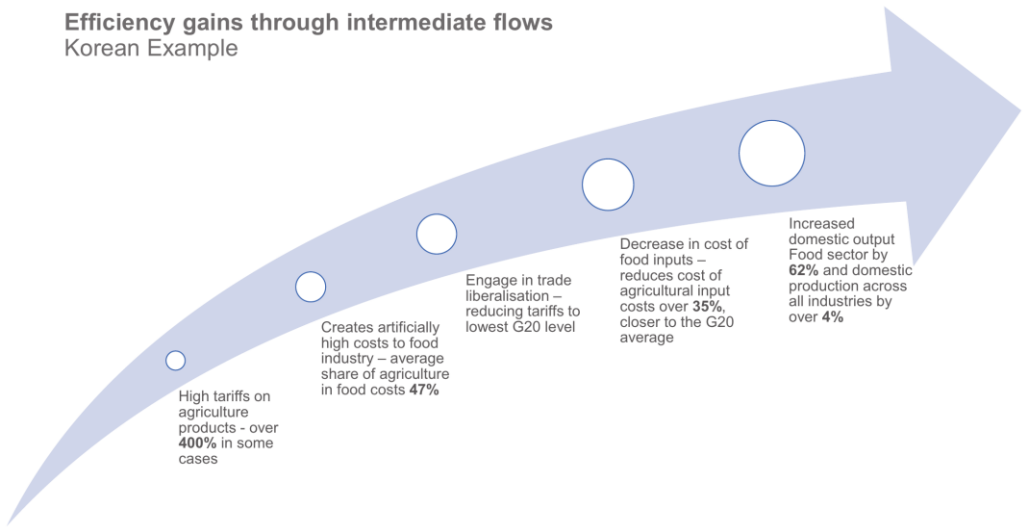
[3] OECD (2019) Global value chains in agriculture, OECD Agriculture Policy Brief Feb. 6 Version,

[4] All examples of Zespri from Chun Young-jun (2017) "The success factors of global agricultural cooperatives," (*in Korean*)

the following page).

The acceleration of GVC trade thus implies that the employment of even seemingly domestic industries such as business services are also increasingly generated through global value chains and thus actually reliant on foreign demand. Apple may not hire U.S. workers to assemble its phones, but as it reduces costs and increases productivity through offshoring to the most competitive suppliers around the world, it hires many people in other stages of production in which the U.S. has comparative advantages, such as in R&D, marketing, or sales. Forcing Apple to re-shore its manufacturing to the U.S.

FIGURE 1.1: SPILLOVER PRODUCTIVITY EFFECT OF TARIFF REDUCTION IN AGRICULTURE TO MANUFACTURING SECTOR



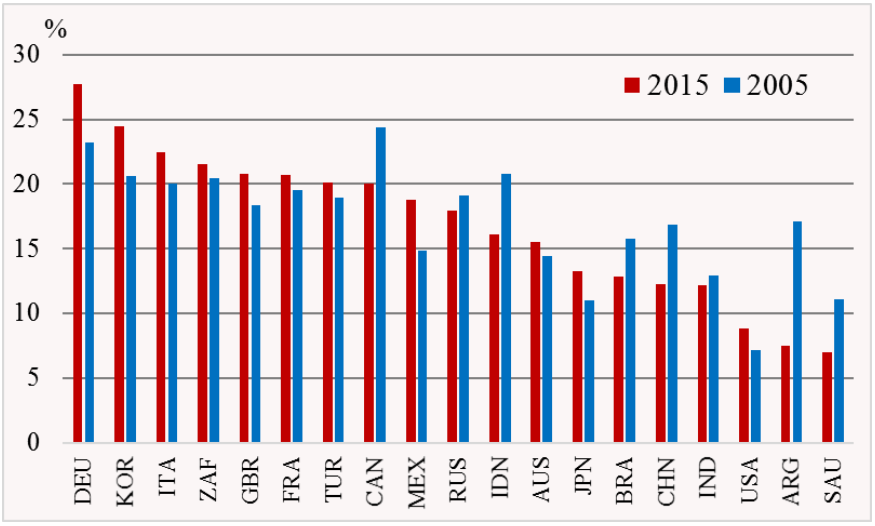
Source: OECD (2018:7), "Trade Policy and the Global Economy Scenario 1: Reducing Tariffs", OECD Trade Policy Brief Oct. 8 Version

would increase costs, leading to more expensive phones, less competitive products and effectively decreasing overall sales. In such a situation, firms and industries within the U.S. that either supply goods and services inputs to Apple or provide downstream marketing, sales and retail functions would also face declining profits and be forced to hire less workers. Likewise, an import restriction on Korean steel, for example, may provide short-term relief for import-competing U.S. steel companies, but causes many U.S. firms that need to use the cheapest, highest-quality steel as a crucial input for production (such as car or aircraft manufacturers among others) to face rising costs and declining efficiency due to being forced to procure inefficiently-produced expensive inputs. Indeed, numerous U.S. companies that use steel and aluminum as important inputs have faced rising costs due to the tariffs imposed in 2018, including beer companies such as Budweiser, heavy equipment and car manufacturers such as Caterpillar and General Motors.[5] In the past, when U.S. cars were mostly produced for domestic consumption, this was slightly less problematic – but in the presence of vertical specialization in global value chains (GVCs), or importing inputs to export, this causes U.S. firms that use imported steel to become less competitive in the global market. U.S. auto firms would then be unable to export as many cars to Europe or Asia as they would have been without the trade barriers, meaning less jobs are created in industries other than steel. The point is that sourcing importing inputs is now crucial for export

[5] Semuels, Alena (2019) "Trump Wants You to Buy American. Here's Why That's Almost Impossible", *Time*

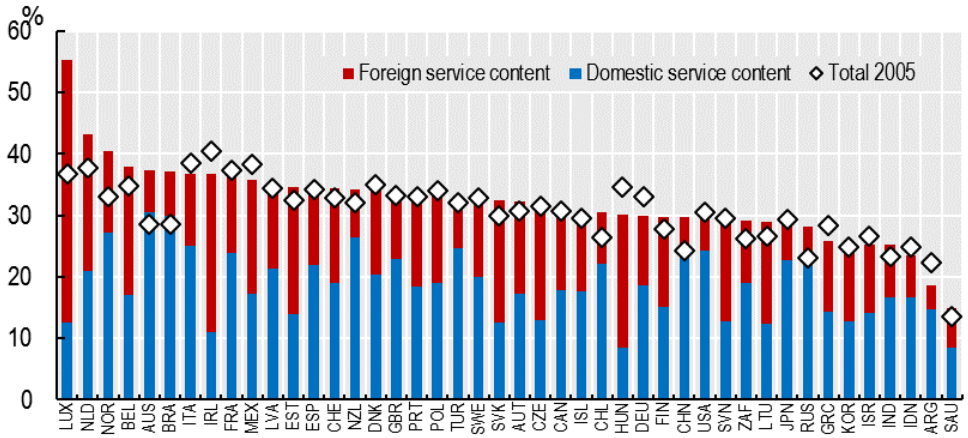
competitiveness. Indeed, as shown in **Figure 1.2**, employment in many countries increasingly relies on demand from foreign markets. **Figure 1.3** shows that even manufacturing exports embody considerable amounts of services value added, while **Figure 1.4** shows that when looking through value added trade data, the role of services exports relative to traditional goods exports rises substantially. Thus, in a world of GVCs, the increasing interconnectedness of previously segregated sectors such as manufacturing and services both within and among different countries makes traditional trade policy and negotiations that focus only on one particular trade partner or industry in isolation less relevant (Miroudot, Rouzet, and Spinelli, 2013). Protectionist policies are highly likely to hurt employment prospects at the economy-wide level, rather than creating more jobs.

FIGURE 1.2. EMPLOYMENT SUSTAINED BY FOREIGN FINAL DEMAND, 2005 AND 2015, (% OF TOTAL EMPLOYMENT)



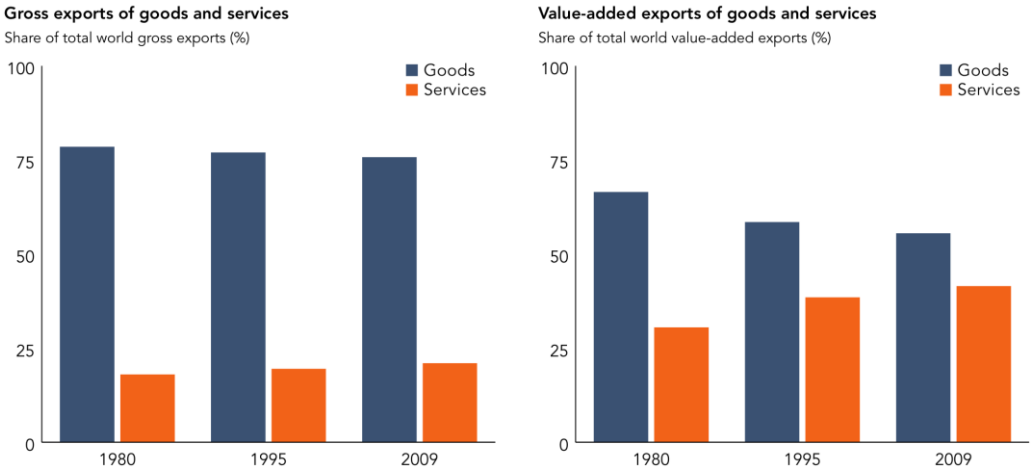
Source: OECD Secretariat estimates based on OECD Inter-Country Input-Output (ICIO) database, December 2018

FIGURE 1.3. SERVICES VALUE ADDED EMBODIED IN MANUFACTURING EXPORTS, BY DOMESTIC AND FOREIGN ORIGIN, 2015 (% OF TOTAL MANUFACTURING EXPORTS)



Source: OECD, Trade in Value Added (TiVA) database, December 2018

FIGURE 1.4. COMPARISON OF GROSS EXPORTS AND VALUE-ADDED EXPORTS OF GOODS AND SERVICES IN 1980, 1995, AND 2009



Source: Dollar (2017:10), Heuser and Mattoo (2017:145)) based on Johnson and Noguera (2017)
Notes: Left is conventional gross trade, right shows trade in value added

In short, the current economic order based on free trade and global value chains has fostered an increasingly high mutual dependence among countries and firms – it is now more difficult than ever to "win" at the expense of others' losses. Considering that the shift from focusing on zero-sum to positive-sum gains from trade may even have contributed to world peace and stability, rising protectionism and loss of trust among world actors may have an adverse effect that cannot easily be reversed. Belief in a continuation of liberal trade policies clearly affects firm-level decision making on overseas investment and sourcing (Ruta, 2017:182). If trust in the persistence of free trade diminishes and the risks of GVCs become perceived to be higher, overseas investment and procurement may be curbed as companies decide to source domestically or in-house, even if these home-country substitutes are less desirable or efficient. Once trust breaks down, and if distortions to economic decision-making spread globally or persist, sub-optimal economic outcomes for all parties will occur. As always, but even more so in a world of global value chains, the disadvantaged segments of society that protectionism claims to "protect" are more likely to lose from protectionism – in order to protect the interests of small, concentrated interest groups that have the power to mobilize policy-making and successfully engage in rent-seeking at the expense of the majority of society (Baldwin, 1989; Olson, 1965).

Although protectionism may not be the solution, it is nevertheless true that casual observation indicates a coinciding increase of income inequality in countries throughout the past decades of hyper-globalization. Aside from causing protectionist pressures,

rising inequality may bring other adverse economic and political outcomes that can be detrimental to overall public welfare. For one, the benefits that accrue from trade may diminish if inequality is exacerbated; for example, Antràs, de Gortari, and Itskhoki (2016) suggested that the welfare benefits from trade may have decreased by 20% in the U.S. from 1997-2007, due to unequal distributional impacts. Empirical evidence on the relationship between economic growth and inequality is mixed, but some recent studies show that the classical trade-off between economic efficiency and equality is not as clear cut as what we used to think, with lower inequality correlating with extended periods of growth.[6] Stiglitz (2013), noting the "hollowing-out of the middle class," contends that inequality hinders the proper functioning of market economies. This is because inequality can lead to more rent-seeking behavior by wealthy actors as economic concentration of wealth and income leads to political concentration of power and more influence on votes. When this rent-seeking influences policymaking, overall economic productivity may be adversely affected. Public interest in inequality has also surged in the past decade, in quieter forms such as the exceptional sales of Thomas Piketty's influential book, *Capital in the twenty-first century* (2013),[7] or in vocal and sometimes violent manifestations such as the Occupy Wall Street protests in the U.S. and the Yellow

[6] See Berg and Ostry (2017). However, not all economists view inequality as a sub-optimal outcome which necessitates intervention: Mankiw (2013), for instance, has suggested that diverging incomes may be due to differences in productivity and therefore economically logical outcomes

[7] Marc Tracy (24 April 2014). Piketty's 'Capital': A Hit That Was, Wasn't, Then Was Again: How the French tome has rocked the tiny Harvard University Press. *The New Republic*.

Vests Movement (*Mouvement des Gilets jaunes*) in France, among many others.[8]

Political scientists have also long examined the potential relationship between economic development, income inequality, regime stability, and change such as democratization (Boix and Stokes 2003; Cho, 2000, 2013; Lipset 1960:31; Przeworski *et al.* 2000, among others). Some researchers state that economic development and modernization contribute as social pre-conditions that serve as a background or even facilitator of democracy, while income inequality may hinder proper functioning of democracy (Lipset, 1960)[9]. Of course, there are many potential factors which may affect inequality within countries, such as the unique ideological orientations and education, labor, or tax policies of governments that directly influence inequality, the level of economic development and technological complexity, the composition of different industries, as well as trade, offshoring, and GVC participation (López-González *et al.*, 2015:16). Considering the rising costs of inequality in today's world, as well as the pressures for protectionism that may distort the functioning of trade in GVCs, it is therefore imperative to address the issue of whether trade, particularly in the context of GVCs, is a key contributor to this trend of increasing income inequality.

[8] The Economist (2019) "The French president responds to the gilets jaunes", Last Accessed 30 May, 2019

[9] Well-known statements in the political literature include, "the more well-to-do a nation, the greater the chances it will sustain democracy" (Lipset 1960:31) and "no bourgeois, no democracy" (Moore, 1966: 418). There have been many arguments that the public must be sufficiently wealthy and well-informed in their decisions in politics for a responsible democracy to work; while at the same time, extreme inequality could foster an oligarchy of power

2. Overview of the Study

While extensive theoretical and empirical research has been conducted for centuries in relation to the impact of traditional forms of international trade, empirical research looking into the distributional impact of globalization utilizing measures of offshoring became widespread only in the 1990s and 2000s.[10] Studies linking individual level panel data with industry level measures of offshoring, which helps deal with aggregation bias and endogeneity problems, have only materialized in the late 2000s (Geishecker and Gorg, 2008). Most importantly, trade in global supply chains may also have new characteristics that affect labor markets differently as compared to traditional non-GVC trade (Hollweg, 2019:64). As an example, aggregate demand for different skills may shift more when "unbundling" of tasks through offshoring occurs (Bacchetta and Stolzenburg, 2019:47). When countries increasingly specialize in stages of production that are either high-skill-intensive or labor-intensive, rather than in entire industries that include both types of stages of production need a more equal mix of the two types of workers, there would be a tendency for the labor market impacts of trade to be magnified (*ibid.*). Analysis based on gross trade statistics cannot properly measure the role of GVC-trade on causing changes in income distribution, and these earlier first-generation measures of offshoring trade have many limitations in accurately depicting GVC-related phenomena. Data on Trade in Value Added (TiVA), which are essential for painting an

[10] For example, Feenstra and Hanson (1999)

accurate picture of global trade in the presence of GVCs, have only become available in this decade, and proxies of GVC participation used in empirical studies have been continuously revised and modified to address earlier limitations. Most importantly, both theoretical and empirical studies on the impacts of trade and offshoring on labor markets have shown ambiguous and sometimes conflicting results.

As such, empirical studies explicitly using one of the most recent GVC participation indices, especially in the context of wage inequality, are still few in number. To the best of the author's knowledge, this research is the first study to examine how the three different types of backward, forward, and total GVC participation indices as well as Value Added Export (VAX)[11] ratio measured at the *industry* level in *all* industries including non-manufacturing sectors such as agriculture and business services[12] interact with the skill level of workers to affect wages at the *individual* level. With the goal of filling an important gap in the empirical literature, the thesis is organized in the following order. The subsequent chapter presents a review of the vast and new literature on global value chains and trade in value added, following with an examination of earlier studies on the labor market impacts of trade and offshoring. This is followed with extant literature on Korea's trade, development, and industrial upgrading strategy as well as

[11] As explained in detail in the main text, backward participation refers to imported inputs or foreign value added within gross exports, forward participation is domestic value added embodied in foreign exports to third countries, total participation is the sum of the two indicators, and the aggregate VAX ratio is domestic value added embodied in foreign final demand divided by gross exports

[12] which as mentioned earlier have taken increasingly important roles in GVCs

position within GVCs. The theoretical and empirical insights from various strands of literature including traditional trade, offshoring, as well as the newest contemporary GVC literature derived from multidisciplinary studies spanning economics, sociology, political economy, and business management are integrated with qualitative characteristics such as the potential skills and business functions potentially embodied in Korea's GVC-related trade in order to construct hypotheses on how the GVC indices may affect the wages of Korean workers. These qualitative characteristics of Korea's composition of imports and exports supplement the limitations of value added trade data in being unable to show the embodied bundles of tasks and business functions that form the essence of global value chains, which must be known to assess the direction of industrial upgrading to higher value added tasks and skill-intensive activities.

A description of the data and empirical methodology is then followed by an examination of fixed effects regression results on three different types of GVC participation as well as alternative specifications such as the VAX ratio and time lags. The research design, choice of data, treatment of variables, as well as inclusion of various controls and fixed effects, are all carefully selected to deal with potential bias and ensure a reasonable degree of confidence in interpreting estimates. Overall the study finds clear evidence of a skill-biased effect, particularly forward participation in the case of Korea. All types of GVC trade lead to higher overall wages for workers but relaxing the assumption of equal slopes for different skills leads to high-skilled workers receiving significantly higher boosts to wages as compared to low or medium-skilled workers.

Contrary to one of the few recent cross-country studies that found significant skill biased effects for backward supply chain trade but not for forward linkages in GVC trade, Korea is shown to have the opposite phenomenon: imported inputs measured as foreign value added in exports boosts overall wages but is not clearly skill-biased, whereas Korean intermediate goods and services used as inputs in foreign countries and re-exported to third countries show a very high skill bias. This finding highlights the importance of addressing heterogeneity in the labor market impacts of different types of GVC participation, which has not been thoroughly addressed in the previous empirical literature on foreign outsourcing. Most importantly, the qualitative analysis on Korea's changing role and position in GVC trade as well as country-specific consideration of the skills and tasks that may comprise Korea's foreign value added in exports, provide a plausible causal explanation as to why the impact of GVC participation may change depending on the specific country or industry question. Korea's backward GVC trade comprises a mix of primary inputs such as raw materials and energy, as well as sophisticated high-skill-intensive intermediates form advanced economies and some low-skill embodying inputs from low income countries, while its forward GVC trade increasingly embodies high skill activities such as R&D, design, and branding. The empirical findings of the quantitative analysis are supported by an additional round of robustness checks, with time lagged vertical specialization measures as well as the sector-level VAX ratio in manufacturing industries showing skill-biased impacts on wages favoring high-skilled workers. Last but not least, aside from finding heterogeneous distributional effects of different types of vertical specialization, this

study demonstrates that all forms of GVC trade have overall positive impacts on wages at the micro-level, which supports the view that protectionist trade policies or export restrictions would mean forgoing the benefits of more globalization of production that accrue from international supply chains.

Because skill-biased impacts on wages may potentially contribute to income inequality, there may be a dilemma where GVC participation may cause populist pressure for protectionism, even though that would be detrimental for aggregate economic well-being. Moreover, if the spread of global value chains is a contributing factor to backlashes against globalization, the current world order based on liberal trade policy and capitalism may be threatened in spite of growing interdependencies between economies, as cooperation among nations as well as firms' overseas investment and outsourcing decisions are based largely on accumulated trust. This is because the productivity gains of GVC participation can only be realized in a liberal trade environment with low risks in supply (export restrictions) or demand (tariffs and other non-tariff barriers). The study should may interest scholars in sociology, political science, and international relations. In a different angle, the fact that Korea's forward GVC trade seems to be associated with industrial upgrading into higher value added functions such as R&D may interest researchers in educational studies, as restructuring education policy to ensure that the most demanded skills are supplied may be more important in overcoming skill mismatches and inequality as opposed to expanding tertiary education. The results of this research should thus be of interest to a wide variety of fields.

II. LITERATURE, THEORETICAL FRAMEWORK & HYPOTHESES

1. Literature Review

1.1. Global Value Chains

According to Kaplinsky and Morris (2001:4) and Gereffi and Fernandez-Stark (2016)

> "The value chain describes the full range of activities that firms and workers perform to bring a product or service from conception, through the different phases of production (such as research and development (R&D), design production, delivery and support to final consumers) and beyond."

Global value chains thus refer to an international dispersion of the different stages in which raw materials and knowledge are transformed into final goods and services. As mentioned earlier, the spread of GVCs means that many products and services are "Made in the World" through cross-border production networks, rather than in a single country. Since countries increasingly specialize in specific *stages* of production rather than in products or industries, it is misleading to attribute products to one country. A "Japanese" car including components from Korea and Germany can be assembled in the U.S., a "Korean" phone made in Vietnam includes U.S. inputs, and a "Made in the U.S." Boeing 787 jet also includes parts from all over the world. Antràs (2016:3-5) thus states that "traditional 'Made in' labels in manufactured goods have become archaic symbols of an old era."

Multinational firms (MNCs)[13] are the main actors in GVCs, focusing on different activities in GVCs, either outsourcing contracts to other arm's-length firms or choosing to vertically integrate activities themselves through their own affiliates (Andrenelli *et al.,* 2019). Both foreign outsourcing and vertical integration through outward foreign direct investment (FDI) constitute offshoring activities which lead to international GVC trade in intermediate inputs. Trade is therefore closely associated with the investment of large multinational enterprises in a world of global value chains. Estimates attribute 55%[14] (to as much as 80%[15]) of global trade to MNC activity.

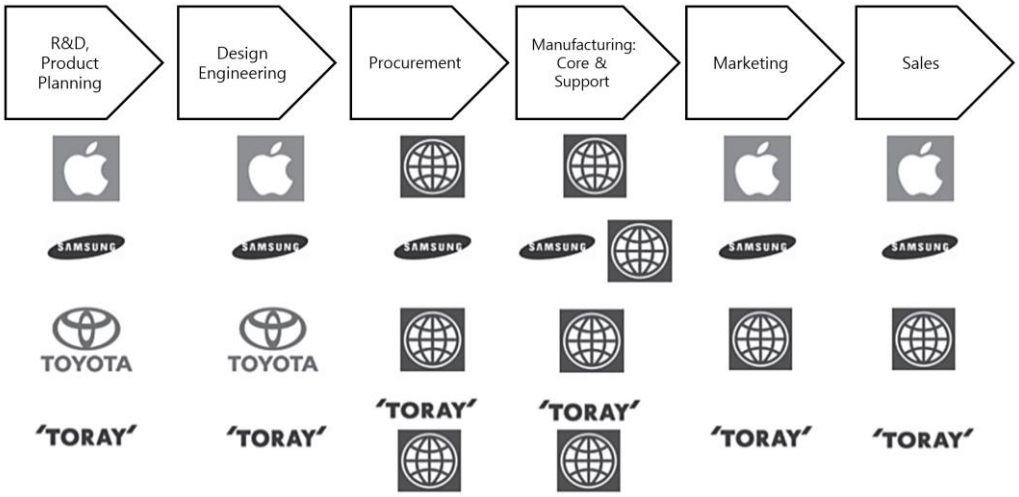
Firms can choose to participate in just one stage or many different combinations of stages of production within global value chains. An example of how global MNCs focus on different stages of production in GVCs is shown in **Figure 2.1** on the next page.

[13] Other international organizations such as UNCTAD (2013) use the term "transnational corporations (TNCs)" and other terms, but for sake of simplicity this study will hereafter refer to such large companies simply as MNCs.

[14] OECD (2019b) "Trade and investment" OECD Trade Policy Brief Feb. 25 Version,

[15] UNCTAD (2013)

FIGURE 2.1: GVC ACTIVITIES OF GLOBAL MNCS



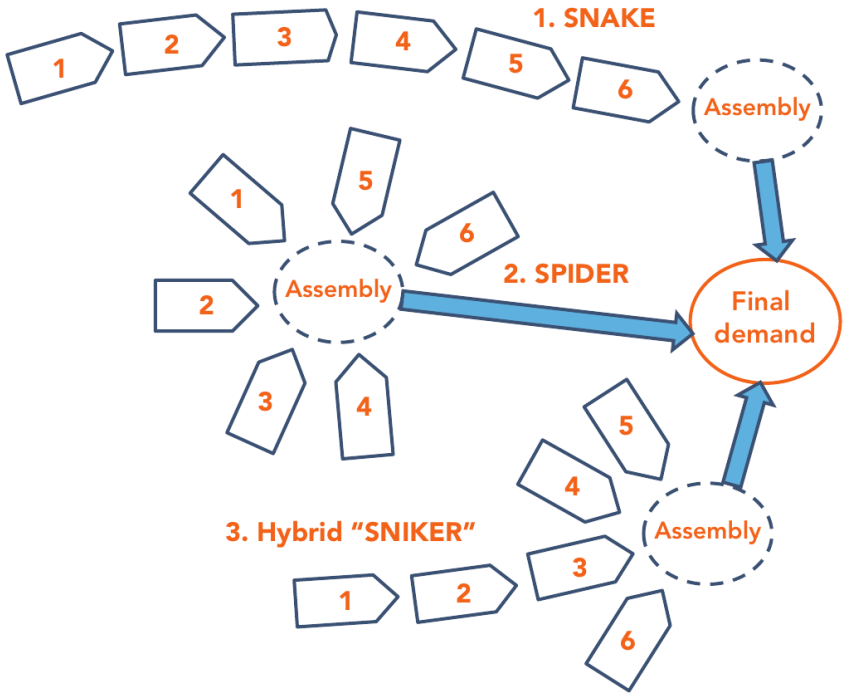
Source: Author's Adaptation of Suh *et al.,* (2014:56)

Apple focuses on upstream and downstream intangible activities in the value chain characterized by high value-added, i.e., R&D, design, branding, sales and marketing as well as software in the U.S. but outsources inputs from overseas (Suh *et al.,* 2014:53-57). On the other hand, Samsung is vertically integrated in much of its activities – although it has numerous suppliers and contractors as well, it still participates to some degree in each stage of the value chain. For example, Samsung owns factories in Vietnam that produce its smartphones, while its headquarters in Korea focus on R&D or marketing. Some of Samsung's design centers are located in Europe and other areas outside of Korea, where it deems that design talent can be most competitively sourced.

An interesting aspect of MNC activity in GVCs is that companies compete in some markets but cooperate in others. For instance, Samsung also happens to be an important supplier to Apple - providing microprocessors, memory chips, and even the OLED

screens or "Super Retina" displays used in high-end iPhones, although the two companies are also competitors in the smartphone market. Thus, when demand for Apple's products increase, suppliers such as Samsung also find their sales increasing. It is also well-known that the assembly activities of Apple are done in China, with partners such as Foxconn (Hon Hai Precision). Therefore, although Apple is headquartered in the U.S., it is deeply involved in coordinating Asian supply chains. It should be noted that the concept of a sequential chain is a simplified construct, as depending on the good or service examined, the global value *chain* may resemble more of a complex web or network, which Baldwin and Venables (2013) described as "snakes" and "spiders."

FIGURE 2.2: SEQUENTIAL GVCS VS NETWORKS: SPIDERS, SNAKES, AND HYBRID SNIKERS



Source: Escaith's adaptation of Diakantoni *et al.,* (2017) and Baldwin and Venables (2010)

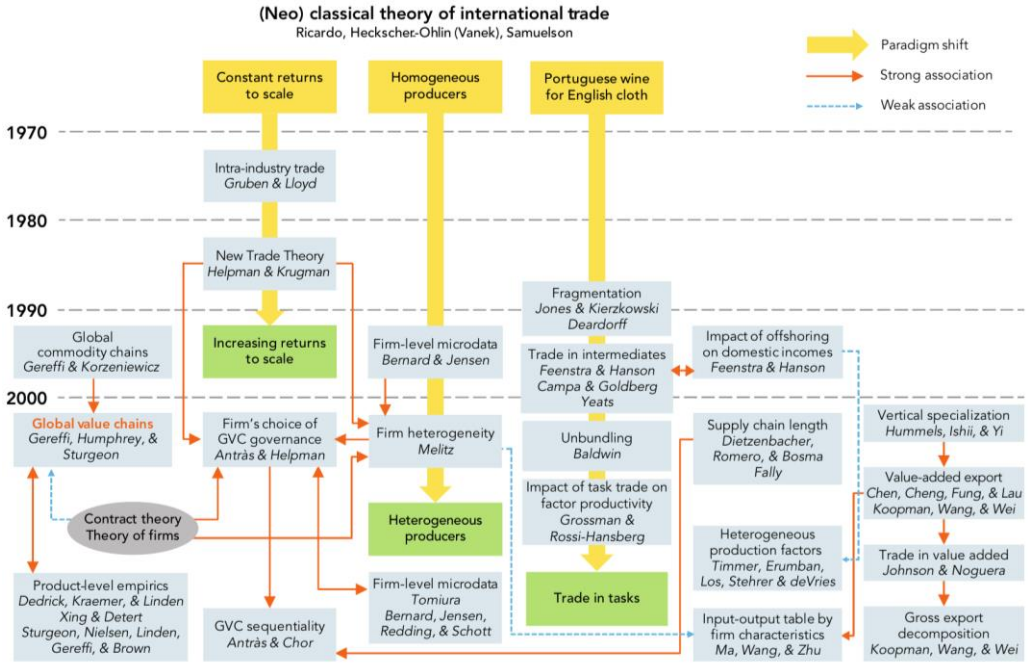
For the purposes of measuring value added trade at an aggregate level, however, the specific form of the GVC is not very important. Today, GVC-trade constitutes 70% of international trade, which has complicated matters related to policy-making as well as properly examining the effects of trade (OECD, 2018b). An example of GVC-related trade would be Samsung importing rare earths and other components from China and Japan to make its semiconductors and OLED displays, and then re-exporting memory chips and displays back to China, where those chips are used in the assembly of Apple's iPhones – ultimately reaching the United States. Each stage and input would also have its own value chain, however, so to do a detailed analysis of trade at the national economy level, input-output tables must be utilized, rendering the snake and spider distinction less important. A detailed explanation on the new importance of measuring value-added trade in contrast with conventional trade statistics will be provided later on in this chapter, after examining the development of the terminology and literature on global value chains, as well as discussing the new implications and insights that this multidisciplinary framework has brought into the economic trade literature.

1.1.1 Concept, History and Terminology

Global value chains have been characterized in diverse ways by scholars of various academic fields[16]. Historically adopted terms among economists include "vertical specialization (Balassa 1967, Hummels *et al.,* 2001)," "multistage production Dixit and Grossman (1982)", the "slicing of the value chain (Krugman 1995)," "disintegration of production (Feenstra 1996)," "international fragmentation of production (Jones and Kierzkowski 2001)", "global production networks (Henderson *et al.,* 2002)," "trade in tasks (Grossman and Rossi-Hansberg 2008)," "the second unbundling (Baldwin 2012)," "global supply chains (GSCs, Baldwin 2013)," "offshoring," and many more. Most of these terms will be used interchangeably in the rest of this thesis along with global supply chains and GVC-related trade depending on the context. Sociologists and political economists have also used the term "global commodity chains." The concept of the global value chain used in this study as well as in the previous literature is thus interdisciplinary in nature: it originates in the concept of global commodity chains in sociology (Gereffi 1994) as well as Michael Porter's value chain (1985) from business management studies. Researchers from economics, political science, business management, as well as policymakers have contributed to the literature (Elms and Low 2013). Inomata (2017) provides a genealogical map of the literature on how GVC studies have contributed to international trade studies, as shown in **Figure 2.3** on the next page.

[16] See, for instance, Antràs (2016:5), Das and Han (2013:278), Taglioni and Winkler (2016)

FIGURE 2.3: LINEAGE OF ANALYTICAL FRAMEWORKS FOR GLOBAL VALUE CHAINS



Source: Satoshi Inomata (2017)

Classical international trade theory was based on the assumptions of perfectly competitive markets and constant returns to scale, as well as homogeneous producers in industries. After Adam Smith's intuitive theory of absolute advantage, one of the most famous trade theories that still maintains powerful influence today was established: the theory of comparative advantage by David Ricardo (whose model was formalized by Mill), with his famous example of trading Portuguese wine and British cloth. Even if the United Kingdom can produce both wine and cloth more efficiently than Portugal (absolute advantages in both goods), it may be beneficial for the two countries to engage

in trade, as both can have a comparative advantage (the U.K. can produce textiles and Portugal wine while sacrificing less opportunity cost, since the U.K. is relatively even more efficient in producing textiles compared to wine and Portugal is less inefficient in producing wine). Heckscher-Ohlin theory (formalized largely by Samuelson) further developed the idea of comparative advantage based on differences in factor endowments among countries.[17] A new generation of trade theory that attempted to explain the rise of intra-industry trade among countries emerged in the latter half of the 20th century. New Trade Theory was based on monopolistic competition, in which imperfectly competitive markets occurred naturally due to economies of scale internal to firms (Krugman, 1979). This New Trade Theory was better suited to explain trade among countries with similar factor endowments. It demonstrated that even in the absence of comparative advantage, both trade and gains from trade would occur. According to Inomata (2017), in the 1990s, economists such as Bernard and Jensen (1995) began to examine the validity of previous trade theories which were based on the assumption of homogenous producers, finding that real-world observations based on firm-level micro data showed that even in the same industry, exporting firms were significantly more productive then non-exporting firms. These empirical observations of coexisting firms with heterogeneous productivity were supported with the theoretical explanations of economists such as Melitz (2003), whose descriptions were later dubbed "New-New

[17] The distributional impacts of trade on labor markets based on these trade theories will be discussed in more detail in the following chapter on labor market impacts of offshoring and GVCs

Trade Theory" (Inomata, 2017:16).

Most important for our purposes is the next, newest wave of trade theory that is focused on explaining various forms of economic phenomena in relation to the expansion of global value chains, such as the rapid spread offshoring and trade in intermediate inputs, which in some forms can arguably be considered a form of trade in tasks related to production in different stages of the global value chain. This contrasts with trade theories based on traditional trade in final products, or empirical studies that assume that gross trade statistics accurately reflect the content of domestic value added exported to other countries. Firms were already offshoring assembly activities in low-cost destinations in the 1960s, but trade increasingly became reorganized around GVCs in the 70s and 80s when retailers and brand companies began to coordinate production networks in Asia (Cho *et al.,* 2017:15-16). Although this was also noted by some trade economists, trade data based on value added was unavailable at the time. Early studies based on GVCs were rather mostly developed by researchers in sociology and political economy, and this strand of research continued in the 1990s and 2000s, a period when growth in global supply chains reached unforeseen levels. The specific term of "global value chains" was only introduced in the early 2000s, but it has been adapted by international organizations and a growing number of economists as it "successfully captured new characteristics of the global economy (De Backer and Miroudot, 2013:7)." The following section thus briefly examines the contributions of various fields outside of neoclassical economics in explaining various phenomena with respect to the

international division of labor, including their focus on how various actors in the global economy capture and distribute value, how GVCs are linked to industrial upgrading and changing distribution of skills, and finally the way they have brought attention to the importance of measuring trade in value added.

As mentioned earlier, GVC studies originate from a wide range of different academic fields including those outside of economics that developed parallel with each other, but there has recently been significant interdisciplinary research collaboration. Interestingly, although the concept of GVCs is now widely adopted in the mainstream economic literature, the historical origins of the GVC paradigm lie largely in some strands of sociology and international political economy, along with some analytical terminology from business management and industrial organization.[18] Bair (2005), De Backer and Miroudot (2013), and Neilson (2014) among others state that the intellectual origins of GVCs are rooted in the works of world-systems school scholars such as Hopkins and Wallerstein (1977, 1986) in relation to dependency theory. Inomata (2017:19) also states that GVC analysis, which originates in sociology, should not be considered a simple international extension of Michael Porter (1985)'s "*value chain*" concept widely used in business administration and managerial studies, because the underlying interest, objectives, and scope of the terms diverge. The "*commodity chain*" in early studies was devised to "trace back the set of inputs that culminated in this [consumable] item – the prior transformations, the raw materials, the transportation

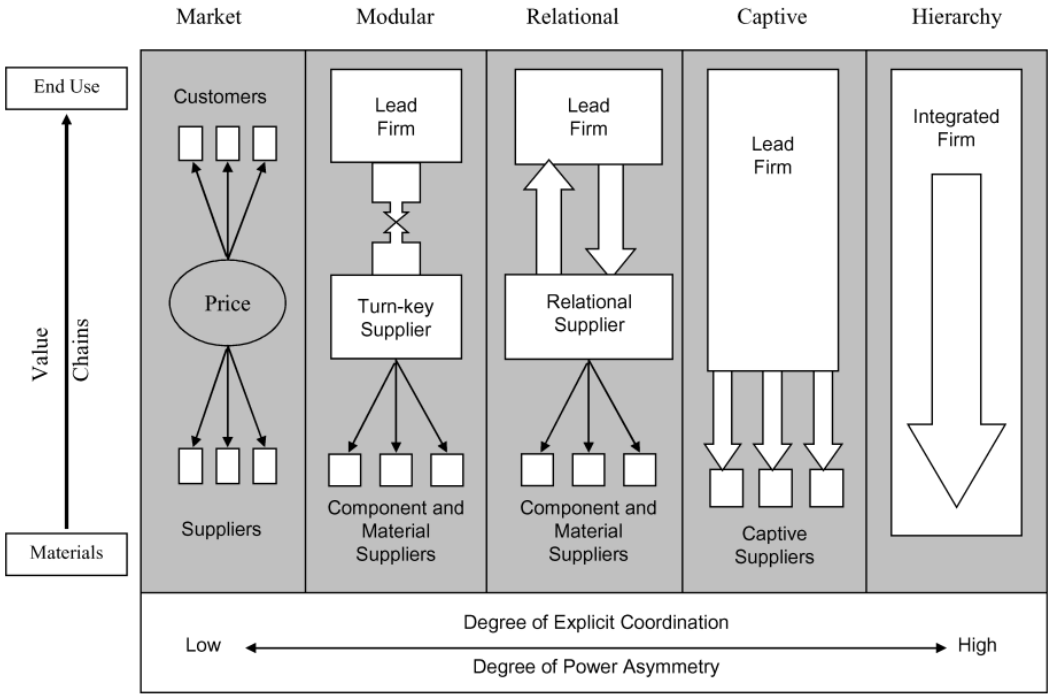
[18] Inomata (2017:17,19), Bair (2005), De Backer and Miroudot (2013:7-8), Nielson (2014)

mechanisms, the labor input… this linked set of processes we call a commodity chain (Hopkins and Wallerstein, 1977:128).” According to Bair (2005), the goal was to devise a new way to examine the international division of labor. A more firm-centered approach interested in issues such as the way that firms sub-contract and assemble products, and reach consumers through networks in global markets, as well as their relation to “organizational and industrial upgrading” began with literature pioneered by Gary Gereffi (1994), who used the term “*global* commodity chain (GCC).” These studies focused on who captures rent in the value chain and how lead firms coordinate value chain activities in different types of global value chains, a field that is now referred to as “global value chain governance.” For instance, Gereffi (1994) examined how downstream US retailers and branded marketers in the apparel industry, which focus on marketing and sales, such as the GAP, shaped and coordinated overseas production networks even without owning equity stakes. He distinguished these “buyer-driven global commodity chains” in close proximity with consumers from “producer-driven” chains characterized by high-tech electronics or capital-intensive industries such as semiconductors, where the powerful lead firms focusing more on upstream activities such as R&D control distribution, suppliers, and other downstream activities .

This two-type typology was later extended to a wider variety, as presented in Gereffi, Humphrey, and Sturgeon (2005), **Figure 2.4.** The goal of this typology was to examine how transactions are conducted and value added distributed among the different players in global production networks, in relation to their bargaining power and degree

of coordination.[19] The researchers in this lineage of GVC research, mostly sociologists, also provided a typology of different forms of industrial upgrading. Humphrey and Schmitz (2002) listed four such types, such as improving abilities to produce more efficiently with new technology (process upgrading), entering more sophisticated product markets (product upgrading), acquiring or abandoning production activities for more skill-intensive functions (functional upgrading) and moving into new but typically related industries (chain or inter-sectoral upgrading).

FIGURE 2.4: TYPOLOGY OF GLOBAL VALUE CHAINS



Source: Gereffi, Humphrey, and Sturgeon (2005)

[19] A detailed illustration of different types of GVCs is beyond the scope of this study. One may refer to ANNEX 1.1 of Inomata (2017) for a brief summary on Gereffi *et al.,* (2005)'s typology

A shift in the terminology from GCCs into global *value* chains (GVCs) occurred in the early 2000s, reflecting greater influence of international business literature as well as the policy orientation of international organizations (Bair 2005). The word "value chain" was coined by Michael Porter in his book, *Competitive Advantage (1985)*, to express disaggregation of production into stages of primary and support activities. The concept has been used in business management to analyze how firms can systematically enhance their competitive advantages with respect to other companies by properly organizing these activities to identify the drivers of cost and ways to build value.

Gereffi, Humphrey, and Sturgeon (2005) point out the multidisciplinary nature of their theoretical typology of GVCs by mentioning how it is based on transaction costs economics (Williamson, 1975), production networks, and technological capability and firm-level learning. Using their typology, the authors state that East Asian economies such as Japan in the 1950s and 60s along with Korea, Taiwan, and Hong Kong in the 1970s and 80s successfully upgraded from captive apparel value chains of simple assembly activities to higher value added stages (Gereffi, Humphrey, and Sturgeon (2005:91). Furthermore, they argue that the modular type of GVC is becoming more important in particularly the information industry, although they mention that there is no one-size-fits-all approach to organizing GVCs as can be seen in largely vertically integrated cases of an electronics firms such as Samsung (Gereffi, Humphrey, and Sturgeon (2005:97). The international business management literature on firms and foreign direct investment has also contributed to this literature. For example, the

"eclectic paradigm" or "Ownership-Location-Internalization (OLI)" theory by Dunning (1977) also analyzes the key factors in whether MNCs engage in arms-length trade, foreign direct investment, or strategic partnerships. The "O" of OLI refers to ownership advantages, which refers to valuable intangible assets such as brands or technology which MNCs need to overcome the costs of being abroad, while "L" refers to advantages that exist in particular foreign locations, such as abundant low-cost labor or large markets. MNCs would directly own subsidiaries if there are large "I" or internalization advantages that outweigh the costs of internalization relative to arms-length transactions (Andrenelli *et al.,* 2019). Recent theoretical advances in the economics literature in a similar vein to these sociologists and managerial scientists have emerged, particularly the property-rights model of firms coordinating global value chains by Antràs (2003), Antràs and Helpman (2004) as well as Antràs and Chor (2013), which also examines how firms decide to engage in arms-length transactions or internalize operations at an international scale in order to minimize transaction costs and exploit locational comparative advantages.

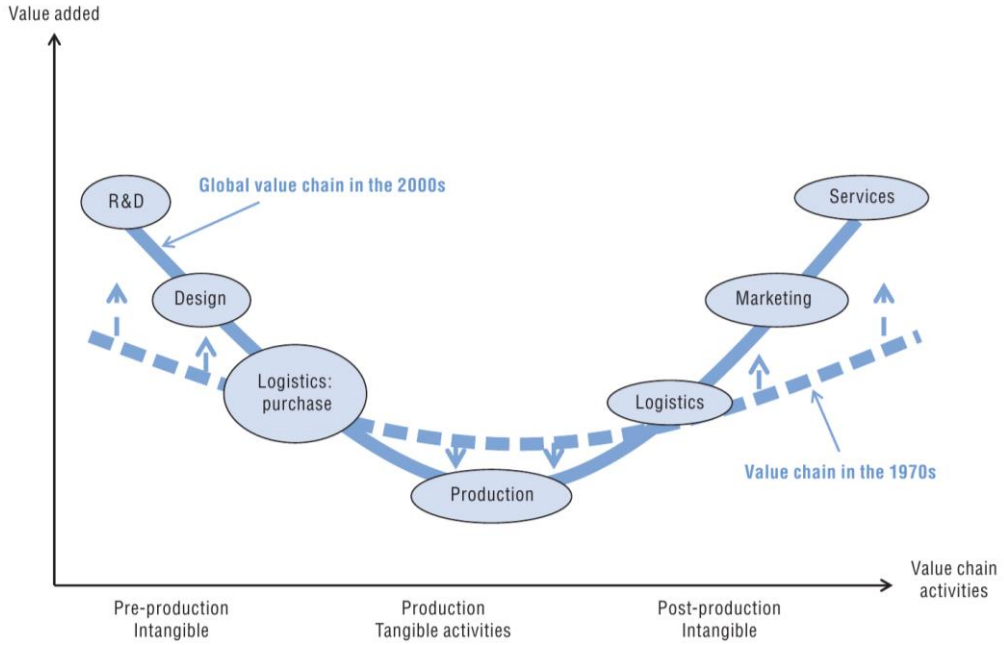
For the purposes of this thesis, an important issue with respect to these activities of firms in GVCs is how they contribute to industrial upgrading and require higher skilled workers, effectively changing the composition of the labor force. This is because companies also transfer firm-specific know-how and technology in GVCs (Taglioni and Winkler 2014). As an example, Samsung's factories in Vietnam would have to bring in its sophisticated management systems and human capital if it wants to make sure that

the Vietnamese factory's production is smoothly coordinated with other activities in the value chain. Maintaining high reliability in production is crucial for the firm's productivity, as even a slight production stop can cause serious damage to each partner in a GVC. For instance, Taglioni and Winkler (2014) underscore the costs of not being able to ensure timeliness of production and delivery, and Hummels (2007) estimates that a 24-hour delay in exports is similar to imposing a 1% or higher tariff for products that are sensitive to time. These risks of GVC shocks forces firms to also consider "just-in case" strategies along with normal "just-in-time" methods of reducing inventory costs (OECD, 2013:255). To minimize adverse production shocks and maintain reliability, MNCs such as Samsung invest heavily in human capital overseas, for instance, training African engineers as well as sending high-performing foreign employees to leadership workshops back in Korea (ACET 2014, Taglioni and Winkler 2014:1-2).

In relation, Gereffi and Fernandez-Stark (2016:22) state that each stage of the value chain has different requirements for the skill level of workers. In particular, the now well-known smile curve, originating from the business literature (Shih, 1996) suggests that developed countries usually specialize in intangible, very upstream or downstream activities with higher value-added content such as R&D or marketing based on brand power, whereas developing countries focus more on assembly and fabrication, which often captures less value added. This implies that countries upgrading to higher value added activities may gain more profit, but will also require more skilled labor to carry out these activities as opposed to unskilled labor. These insights combining

sociology and business literature suggest profound labor market implications with respect to GVCs, but empirical evidence on the smiling curve is mixed, as will be discussed later in this study.

FIGURE 2.5: DEEPENING OF THE SMILE CURVE



Source: OECD (2013:214) based on Shih (1996) and Baldwin (2013)

FIGURE 2.6: TYPES OF OCCUPATIONS IN GLOBAL VALUE CHAINS

Job Category	Examples of Conditions of Work	Education Level	Examples
Informal SME or household work	May or may not be compensated; precarious conditions; unregulated work hours	Low; often less than primary education	Small producers in agricultural supply chains
Low skilled labor-intensive work	Formal; job insecurity, low wages, weak organization due to subcontracting	Low; often primary education or less	Workers on apparel or electronic assembly lines
Moderate skilled work	Formal; increased job security, potentially poor working hours	Completed secondary education	Procurement and logistics handling jobs in apparel and automobile chains
High skilled technology-intensive work	Formal; high job security, higher paid work, working hours & work-life balance challenges	Post-secondary technical education	Specialized component production and assembly in aerospace and medical devices chains
Knowledge-intensive work	Formal; potentially freelance, higher paid work, working hours & work-life balance challenges	Completed university education, including advanced degrees	Accounting, engineering and design jobs

Source: Gereffi and Fernandez-Stark (2016)

1.1.2 Global Value Chains and Value Added Trade Data

In short, the theoretical underpinnings of GVCs are interdisciplinary in nature and were developed in parallel with each other in various fields in the social sciences such as sociology, international political economy, business management, and economics. Each field has been contributing new insights into the recent expansion of international production sharing, with multi-disciplinary research collaboration starting to become more active since the turn of the 21st century (Inomata 2017). Although there are many aspects of different fields in GVC studies that are linked to each other, because the goal of this research is to assess the impacts of GVC related trade on labor markets, the remainder of this chapter will direct its focus on what GVCs imply for traditional

trade statistics, as well as for trade economics in general. However, in formulating the main hypotheses of this study on how GVC participation will affect labor markets, the concepts of the smile curve as well as industrial upgrading will be re-visited.

Building on these theoretical foundations of GVCs, along with some empirical case studies on industrial upgrading, product level tear-down studies looking at firm-specific business records and financial statements on who captures value added began to develop. One of the most famous examples is the now-classic seminal research on the iPod by Dedrick, Kraemer and Linden (2010) (and later the iPhone, see Xing and Detert, 2010). This study referred to how electronics GVCs are characterized by "modular" networks (Gereffi *et al.,* 2005) and attempted to find which actors profit from innovation in GVCs, by showing that although the iPod was assembled in China, Chinese value added captured in the product was only about $5, with firms such as Samsung from Korea and Toshiba from Japan capturing a much larger part of the profits through providing key components such as memory chips and displays. The US-based Apple is the "lead firm" in this network, further capturing the lion's share of profit thanks to its control of key intangible assets such as design, core software, and proprietary standards. Of the iPod's total retail price of $299 in 2005, $144 was the total factory cost, $75 of the margins went to distributers, and Apple's profit was $80. An important insight found here for trade economists was that following conventional trade measures based on gross trade statistics, China seems to be exporting the entire factory cost of the iPod to the US as it is the final exporting country – but in fact, China contributed only $5 whereas

countries such as Japan exported as much as $27 “indirectly” to the US through parts and components used in the production of iPods. This heightened attention to the fact that in the presence of global value chains and international fragmentation of production, countries at the end stage of assembly such as China appear to be highly dominant exporters based on gross trade statistics, when in fact their value-added contribution may be much smaller. Tear-down product level case studies were conducted on numerous other products such as Boeing’s 787 Dreamliner or iPhone (Xing and Detert, 2010), providing interesting qualitative insights on the characteristics of governance and technological transfer in different types of product GVCs, and continuing to draw attention on the distortions that conventional gross trade statistics may show in representing bilateral trade balances (Inomata 2017:23).

However, as Inomata (2017:23-24) and other economists have pointed out, product-level studies also suffer from various limitations. Firm-level data on labor compensation and other costs are not clearly disaggregated, which makes it difficult to properly assess how much value added workers capture (Dedrick, Kraemer, and Linden 2010). It is also impossible to continuously track all the production stages and supply chains that are linked together – for practical purposes, only direct first tier suppliers of inputs are included, while second, third-tier or nth-tier suppliers by necessity cannot be tracked. A value chain analysis of an iPhone can track the OLED displays and memory chips provided by Samsung and other world suppliers, but it would be immensely difficult to continuously do value chain analyses of each and all of these components

(and of the suppliers of the suppliers of those components). It is also difficult to properly measure the increasingly important role of services value added, such as in sales of music through Apple Music and iTunes, since these activities are part of "complementary assets" but precise estimates of their costs and profits are not included in the study by Dedrick *et al.,* (2010).[20]

Therefore, to be of use for quantitative research in trade economics at the national level, a macro-level data recording the trade in flows of value added from production in each country's industries is needed. Economists have used input-output tables to calculate how much a unit of production in a certain industry requires inputs from other industries[21], but these input-output tables were only available at the national level. Because national input-output tables are only adequate for describing domestic supply chain, various initiatives to harmonize the national input-output tables of countries to a global scale have recently emerged, and these international input-output tables form the basis of calculating statistics of trade in value added (Johnson 2014:120). A compilation of selected databases is presented on the next page. Because these international input-output tables provide estimates of how much of an input in an industry in one country is used in the output of other countries, they can be used to track trade in value added among many countries, in contrast with national input-output tables.

[20] The author thanks Sébastien Miroudot of the OECD Trade and Agriculture Directorate for bringing this to light

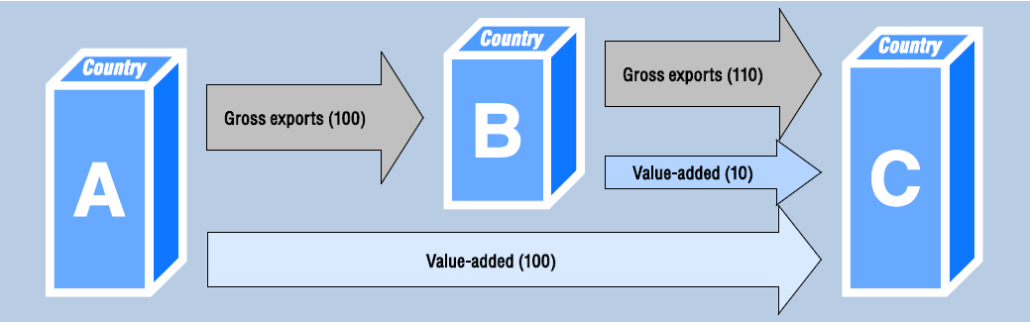
[21] See, for instance, Leontief (1953)

FIGURE 2.7: SELECTION OF INITIATIVES TO MEASURE VALUE ADDED TRADE

Name of Project	Institutions	Data Sources	Countries	Industries	Years	Comments and Key Features
UNCTAD-Eora GVC Database	UNCTAD/Eora	Eora multi-region input-output (MRIO) table from National Supply-Use and I-O Tables, as well as Eurostat, IDE-JETRO and OECD	187 (2013)	25-500 depending on country (2013)	1990-2015 (2018)	"Meta" database combining multiple sources and interpolating missing points to provide broad coverage, including data-poor countries
Global Trade Analysis Project Database (GTAP)	Purdue University	Contributions from individual researchers and organizations	129 (2013)	57 (2013)	2004, 2007 (2013)	Unofficial dataset; includes areas such as energy, land use, carbon emissions and migration
World Input-Output Database (WIOD)	Consortium of 11 institutions, EU funded	National Supply-Use tables	40 (2013)	35 (2013) 56 (2018 UNCTAD)	1995–2011 (2014) / 2000-2014 (2018)	Based on official National Accounts statistics; covers major emerging markets and OECD countries
IDE-JETRO Asian Input-Output Tables / Asian International I-O tables	Institute of Developing Economies (IDE-JETRO)	National accounts and firm surveys	10 (2013)	76 (2013)	1975,1980, 1985,1990, 1995,2000, 2005	Regional tables of 8 East Asian countries, U.S.-Asia and bilateral tables, including China-Japan
WTO-OECD TiVA (Trade in Value Added) Database	OECD/WTO	Inter-Country Input-Output Model (ICIO) derived from National I-O tables	64 countries as of 2019	Now covering 36 industires	1995, 2000, 2005, 2008, 2009 (back in 2013) / 2005-2015 (Current 2018 ver.)	Information on all major OECD and G20 economies as well as majority of Asian countries

Source: Author's Compilation of OECD (2019), Johnson (2014), and UNCTAD (2013, 2018)

FIGURE 2.8: SIMPLIFIED CONCEPT OF TRADE IN VALUE ADDED



Source: OECD (2013), Ahmed (2013)

The concept of value added trade can be easily understood using the example of the iPod and iPhone product-level studies. Country B in Figure 2.8 can be thought of as China, and country C the United States. If China imported $100 worth of inputs from Country A (i.e., Korea), assembled the inputs with $10 worth of domestic inputs and labor, and then re-exported an iPod at a cost of $110 dollars to the U.S., conventional statistics would calculate the transactions as $100 of exports from Korea to China, and $110 exported from China to the U.S. However, value added trade shows that Korea would be indirectly exporting $100 worth of value-added to the U.S., and China would only be contributing $10 of value-added. Another hypothetical example of how trade in value added works in a context of GVCs is provided on the following page.

FIGURE 2.9: CALCULATING TRADE IN VALUE ADDED,
HYPOTHETICAL ELECTRONICS GLOBAL VALUE CHAIN

Source: Author's Own Drawing

Figure 2.9 on the previous page once again highlights the difference between trade in value added terms against conventional gross terms. The earliest stage of a simplified electronics GVC is comprised of extractive industries.[22] Countries such as China may provide early stage resources such as fluorite and sulfuric acids, which are transformed in the second stage by countries creating sophisticated intermediate goods, such as Japan. Japan imports $45 worth of chemicals from stage 1 to export refined high-purity hydrogen fluoride, fluorinated polyamide, photoresists needed to make displays and semiconductors. In gross terms, Japan exports $200 to Korea, while it makes $155 in value added. Korea uses these goods to export $500 ($300 value added) of semiconductor memory chips and display panels, and China assembles them to export an iPhone to the U.S. at a cost of $600. Apple sells the phone at $1000, with $400 of value added in the U.S. either going to Apple, or to other companies involved in retail, transportation, insurance, marketing, or sales. The important point here is that China is exporting $45 (from stage 1) + $100 (stage 4)= $145 of value added to the U.S., while Korea and Japan are respectively exporting $300 and $155 of value added to the U.S. Conventional trade statistics, in contrast, would simply show China as exporting $600 to the U.S. with no trade occurring between the U.S. and the other value chain actors more upstream. Even disregarding the fact that economists usually do not worry about bilateral trade imbalances (which occur due to savings-investment gaps), the trade in value added approach shows that a decision from the U.S. to impose tariffs on phones

[22] At the firm level, analysis would start in R&D activities, but country-sector level analysis on value added trade usually starts from the beginning of material production due to limitations of data

made from China to try and reduce the bilateral trade deficit is likely to be misled. Likewise, an export restriction on rare earths or other key components needed in the production of Korea's semiconductor industry would have negative repercussions on all firms downstream that use these parts. As a realistic example, Japanese firms control 90% of production in high-purity hydrogen fluoride, while South Korean firms such as Samsung Electronics and SK Hynix dominate 50-70% of the world market for semiconductors. Aside from the fact that Apple and numerous other global MNCs would have problems in producing their own goods, an export restriction on this key input for semiconductors would also affect the production of Samsung and SK's own factories located in China, which are responsible for 25 and 40% of production for each firms' respective output.[23] Thus, trade in value added data highlights the risks that GVC participation brings under a world of political uncertainty, which was mentioned in the introduction. More important for the methodological underlying the empirical analysis in this thesis is the fact that data on value added trade allows the construction of new indicators on GVCs that are better equipped to describe vertical trade as opposed to earlier proxies. The development of these new indicators and their implications will be discussed in more detail in the following section on the labor market impacts of trade, offshoring, and global value chain participation.

It should be noted, of course, that trade in value data also has limitations: Ahmad

[23] Yonhap News (2019) "Japan's Export Restriction on Semiconductor Inputs Would Affect China," 20 July, (*in Korean*)

(2019:156) states that the assumptions underlying the TiVA data lead to downward-biased estimates of the degree of GVC integration. For instance, the usage of basic prices instead of free-on-board (F.O.B) prices leads to an underestimation of the amount of domestic value added as well as number of jobs created within the U.S. thanks to imports (*ibid.)* Moreover, value added trade data is not based on business functions, which can lead to some difficulties in interpreting the task content of trade. This problem is examined in later chapters examining the activity composition of Korea's backward and forward GVC trade. The latter part of this section instead focuses on new insights on some of the qualitative characteristics of GVC-related trade that these trade in value added statistics have brought. These insights will be considered when discussing the limitations of previous studies on the relationship between international supply chain trade and income distribution.

1.1.3 Importance of Trade in Value Added

Global value-added trade statistics have only recently become available but have already contributed to showing many new characteristics of world trade, including the interconnectedness of national economies and industries previously thought of in isolation. For one, trade policy based on conventional statistics may be misguided, as bilateral trade balances change significantly. Value added trade properly traces which country is exporting to whom, whereas gross statistics released by governments ascribe the entire value-added to the most downstream or final country in the value chain (such as China), leading to exaggerated attention on trade imbalances with these countries.

This data also shows how imported imports are now increasingly used in production, increasing the costs of trade barriers.[24] By showing the increasing role of foreign value added in trade, value added trade data demonstrates that imports do not necessarily compete or substitute domestic industries – rather, sourcing optimal foreign inputs is directly linked to export competitiveness and growth in productivity. In a similar context, accurate tracing of where value added is exported allows better calculations of the degree that an economy is exposed to demand and supply shocks in other countries (Johnson 2014:28). Value added trade data thus shows the hidden nature of interconnectedness between different national economies by showing both direct bilateral trade as well as *indirect* trade at the aggregate country-level. For instance, if U.S. demand for smartphones imported from China falls, Korea, Japan, and other upstream suppliers will be affected. Measuring the degree of exposure that Japan has to changes in U.S. demand would thus require value added trade data, since the gross exports of Japan to the U.S. would not show the Japanese inputs that have been embodied in Chinese exports to the U.S. A simplified but highly intuitive example was shown in Figure 2.9, of trade in value added flows under a hypothetical electronic value chain. Finally, trade in value added data provides quantitative evidence on indirect trade at the industry-level as well, with industries such as agriculture and services showing much higher trade in value added in comparison with conventional gross trade statistics. Before discussing the labor market implications of GVC participation, the role of services in GVCs may be important

[24] For a discussion on the impacts of GVCs on trade policy, please refer to the introduction

enough to deserve separate treatment.

1.1.4 The role of services

Much of the previous literature on labor market impacts of offshoring have focused on manufacturing industries, because manufacturing is much more fragmented and constitutes a larger proportion of GVC-related trade. However, both theory, qualitative and recently quantitative evidence based on value added trade data show the importance of services in GVCs (Low 2013). The first issue is the so-called "servicification" of manufacturing, which describes the increase in the use of services inputs and blurring of boundaries between goods and services, as they are increasingly bundled together as solutions. (Low, 2013:66, Kommerskollegium, 2010a, 2010b, 2012, Miroudot, 2019). For instance, Apple is a manufacturing firm that does not produce its own phones, and when people buy iPhones, they often buy services such as updates on iOS software and subscription services such as Apple Music that are provided together with the phones. Moreover, in global value chains, services such as finance, transport, and communication act as key links in coordinating manufacturing activities among different countries (Jones and Kierzkowski, 2001). At the same time, manufacturing companies increasingly produce business services such as strategy consulting, marketing and sales, and other activities in-house. These qualitative observations on the growing prominence of services has been validated thanks to trade in value added data. UNCTAD (2013:135) estimates that nearly half of the value added in exports can be traced to service activities, even though conventional trade statistics only attribute about 20% of world exports to

service activity. **Figure 1.3** in the introduction demonstrated that even manufacturing exports embody considerable amounts of services value added, while **Figure 1.4** showed that value added trade statistics greatly reduce the relative discrepancy between manufacturing and services trade. This has many important implications – for instance, Johnson (2014:129) states that foreign demand and supply shocks affect service sectors more and manufacturing industries less when using models with trade in value added data, since there is an increased role of services in value added trade as opposed to traditional trade statistics. Likewise, Nagengast and Stehrer (2016) demonstrated that changes in the structure of GVCs not only influenced a large proportion of the collapse in trade following the Global Financial Crisis in 2008, but also that service industries that supply inputs to exporters also suffered much more than previously understood through conventional trade data. This is because traditional statistics showed much wider fluctuations in manufacturing trade compared to services trade. This crucial role of services is therefore considered in the labor market implications of GVC participation – and contrary to many previous empirical studies, this thesis will include workers employed in non-manufacturing sectors such as agriculture and services along with traditional manufacturing employees.

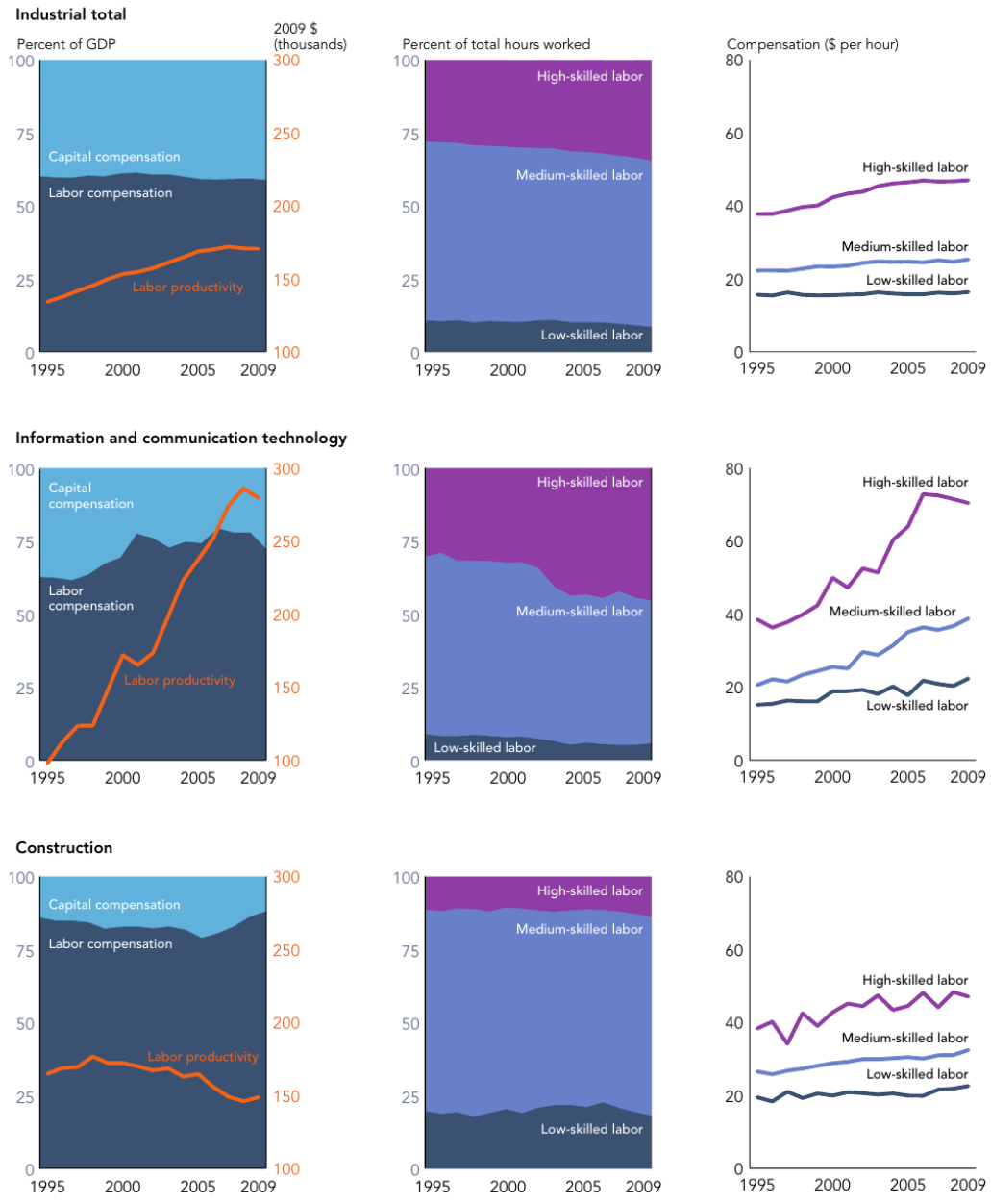
1.2 Labor Market Impacts of Trade and Offshoring

Trade, particularly import competition, has been accused as a culprit of declining domestic industries and a cause of unemployment and income inequality for centuries. Bacchetta and Stolzenburg (2019:46) note examples as early as the 1887 British Merchandise Marks Act, which was instigated to deal with imports of German products. Historical figures such as George Washington, Alexander Hamilton, and Abraham Lincoln were well-known protectionists,[25] and the famous theory of comparative advantage by David Ricardo was developed partly to oppose the Corn Laws of the early 19th century, which restricted imports of grains into the United Kingdom. There has nevertheless been a general decrease in trade barriers and a spread of trade liberalization since the end of World War II, as the gains from trade were better understood, and protectionism was viewed as a threat to economy prosperity and world peace. Nevertheless, the increased growth of trade was periodically interrupted with trade restrictions, such as the U.S. pressuring Japan to impose "voluntary" export restraints in the 1980s. Backlashes against globalization were usually based on the actual observation (although not necessarily causation) that unemployment and income inequality was rising in tandem with the growth in trade. Moreover, deindustrialization has been concentrated in regions characterized either by the decline of import-competing industries, or the offshoring and relocation of production facilities to foreign locations.

[25] Gebelhoff, Robert (2016) "Donald Trump praised the protectionism of Abraham Lincoln. I call foul." 23 June, *The Washington Post*,

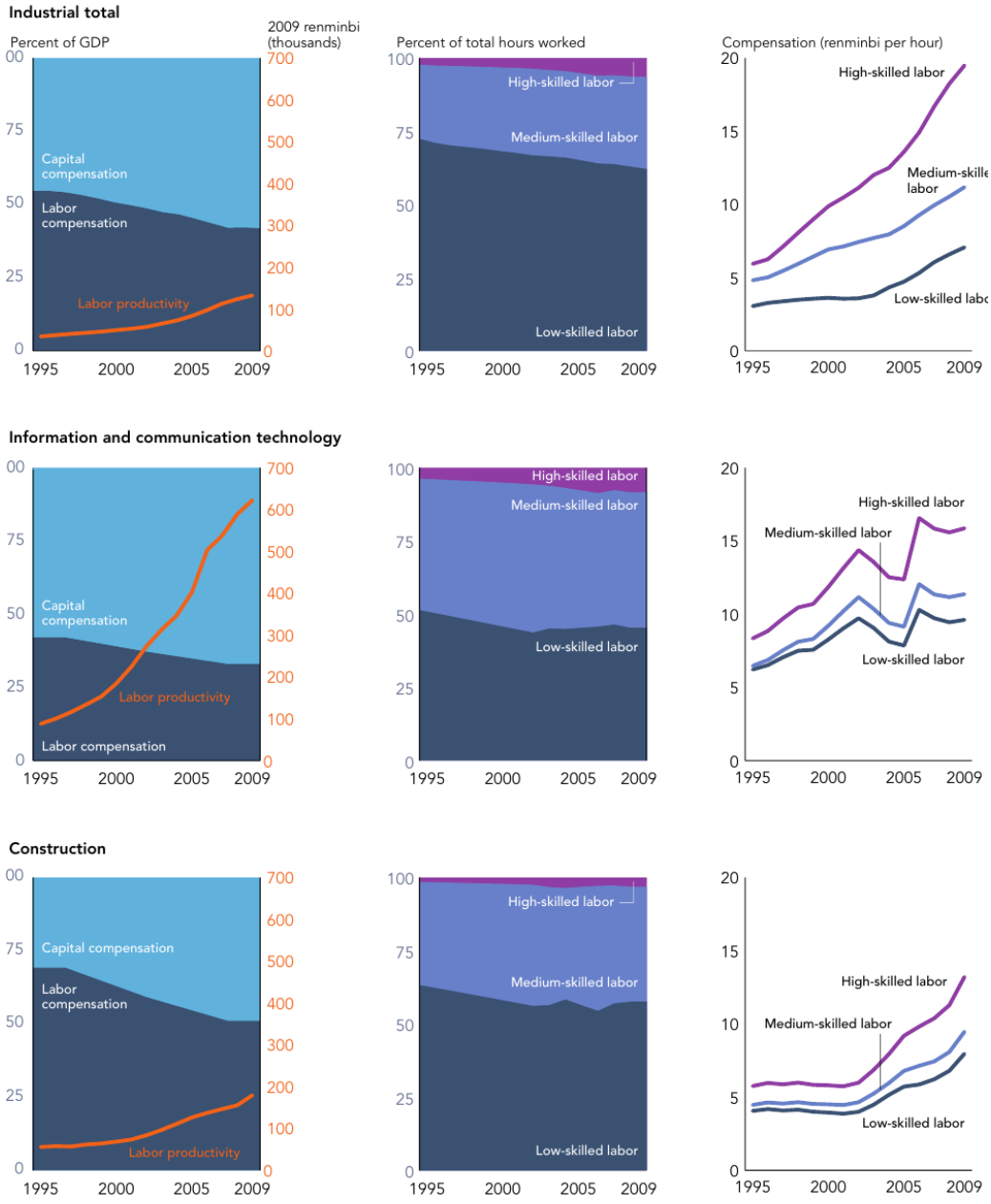
It is perhaps not surprising then that the recent exponential growth in trade due to global value chains has led to renewed and stronger protectionist backlashes, even as the potential harms of protectionism have become larger than ever. Most recently, the surge in Chinese imports has led to a trade war between the U.S. and China. An observation of the changes in the compensation of low, middle, and high-skilled labor during the period of China's rapid integration into global value chains allows an intuitive understanding of growing resentment against globalization. In the following two figures by Meng, Ye, and Wei (2017), one can observe that the return to different factors of production changed considerably during the explosive growth of global supply chains from 1995 to 2009. In the U.S., the share of hours worked as well as labor compensation increased disproportionately for university-graduate high-skilled workers in contrast with low and medium-skilled workers, particularly in the ICT industry, one of the most heavily fragmented sectors in GVCs (Dollar 2017:3-6). During this period, much of assembly and manufacturing moved abroad, while U.S. firms such as Apple specialized more in intangible, higher value added activities in value chains such as R&D, design, and marketing functions. At the same time, perhaps due to the many manufacturing jobs that had been offshored to China, there was a sharp increase in compensation to all Chinese factors of production. Although capital and high-skilled workers gained disproportionately more in China as well, the difference with the U.S. was that the benefits of growth clearly accrued to low and medium-skilled workers as well.

FIGURE 2.10 LABOR PRODUCTIVITY AND INCOME DISTRIBUTION FOR THE UNITED STATES, 1995–2009



Source: Degain, Meng, and Wang (2017)'s adaptation of Meng, Ye, and Wei (2017)

FIGURE 2.11 LABOR PRODUCTIVITY AND INCOME DISTRIBUTION FOR CHINA, 1995–2009



Source: Degain, Meng, and Wang (2017)'s adaptation of Meng, Ye, and Wei (2017)

It seems clear then that the potential relationship between growing income disparities in many countries, together with the deepening of GVCs around the world, clearly deserves proper academic examination. Since reducing income inequality and improving the overall economic prospects of workers are also important issues for policymakers, empirical examination of how the wages of workers have been impacted from exposure to globalization in the context of global value chain participation is paramount. While extensive theoretical and empirical research has been conducted for centuries in relation to the impact of traditional forms of international trade, empirical research looking into the distributional impact of globalization utilizing measures of offshoring have only materialized recently in the 1990s and 2000s. This is partly since proxies of GVC-related trade, as well as data on trade in value added itself, have only recently become available. As there are probably similarities as well as differences between GVC-trade and conventional forms of trade, this chapter provides an overview of the literature on the labor market impacts of both conventional and GVC-related trade in general. The chapter underscores that both the theoretical and empirical evidence on how GVCs affect income distribution is not as clear-cut as seems. As Marcolin, Miroudot and Squicciarini (2016:8) note,

> "…no true consensus has been reached on the direction of causality and the mechanisms at stake…it remains to be assessed whether the ambiguous evidence of the impact of higher engagement in international markets on wages and employment remains once looking at the context of global value chains in particular."

The remainder of this chapter will show that whereas many empirical studies on

offshoring have indeed found a skill-biased effect on labor markets, there have also been studies showing that GVC participation can reduce wage inequality (López-González, Kowalski, and Achard 2015).

1.2.1 Benefits of trade

The fact that trade contributes to economic growth is well established in both the theoretical and empirical literature (Dollar 1992, Rodrik 1995, Sachs and Warner (1995), Frankel and Romer 1999, among others). Gains from trade accruing from specialization and comparative advantage[26] have been known for centuries. To quote Sachs and Warner (1995:3):

> "…the power of trade to promote economic convergence is perhaps the most venerable tenet of classical and neoclassical economics, dating back to Adam Smith. As Smith's followers have stressed for generations, trade promotes growth through a myriad channels: increased specialization, efficient resource allocation according to comparative advantage, diffusion of international knowledge through trade, and heightened domestic competition as a result of international competition."

Furthermore, the New Trade Theory in the latter half of the 20th century based on models of imperfect competition showed that even in the absence of comparative advantage, intra-industry trade can arise due to economies of scale and provide gains from trade

[26] For comparative advantage, please refer to chapter 2, section 1 in this thesis. See Ricardo (1817), Mill (1849), Samuelson (1948, 1949) among others for the original works on comparative advantage and the Heckscher-Ohlin Theorem

(Helpman and Krugman, 1985). Specifically in the modern trade literature, access to a wider variety of cheaper or better inputs (Grossman and Helpman, 1991) more competition among import-competing domestic firms (Helpman and Krugman, 1985), exporters learning from buyers in foreign markets as well as foreign competitors (Balassa, 1978), allocation of labor and other factors to more productive firms (Melitz, 2003) were all shown to contribute to increased productivity (Ahn and Duval, 2017:38). Frankel and Romer (1999), for example, examined the impact of trade on growth in a large set of countries, using geographical instrument variables to deal with endogeneity issues.

Recent empirical studies have continued to show that trade positively affects productivity in both developed and developing countries. In developing countries, trade facilitates allocation of labor into more upgraded industries. For example, McCaig and Pavcnik (2018) examine how increased export opportunities induced by the tariff reductions on Vietnamese exports following the U.S.-Vietnam Bilateral Trade Agreement transformed the internal structure of Vietnam by allocating workers from less productive informal or microenterprise sectors to the formal firm sector. According to the authors, labor in the formal enterprise sector earn higher wages and are more likely to receive other benefits compared to workers in the informal sector. As a recent example for developed countries, Ahn and Duval (2017) examined how advanced countries and industries exposed to more trade with China experienced productivity gains, although they found evidence of some negative distributional impacts on the labor market. In fact,

while it is possible to boldly state that there is a consensus among economists that trade itself contributes to productivity and growth, the literature on the distributional impacts of trade have shown conflicting results, depending on the methodology as well as theoretical assumptions.

1.2.2 Traditional Trade and Inequality

Earlier research examining the potential impact of globalization on within-country inequality did not distinguish between GVC-related trade or offshoring trade, as such trade was relatively less prevalent. One of the seminal studies arguing that expansion of trade was a key cause of inequality in developed countries was by Adrian Wood (1994). The 1970s and particularly 80s had been characterized by relatively stagnant growth in the real wages of lower-skilled production workers as opposed to high-skilled white-collar workers, with the wage premium on education rising (Feenstra and Hanson 1999:907, 2016:1). According to Epifani and Gancia (2008), the skill premium on education increased at an average rate of 8% in the 1980s in 35 developed and developing countries. Wood's study was thus motivated by the increasing social unrest of unemployed youths in England and the polarization of the U.S. at the time of his writing. The theory underpinning Wood's study was a variant of the Heckscher-Ohlin or H-O model divided into two factors of production (skilled and unskilled labor) as well as two types of products (skill-intensive and labor-intensive manufactures) (Wood 1994:27). The main logic behind the H-O theorem is that countries export goods that intensively use the factors of production (labor, capital, or other factors needed to

produce a product) that are relatively abundant in their respective countries. Wood states that because the "North" or developed countries had an abundance of skilled labor whereas the "South" had more low-skilled workers, trade based on comparative advantage would result in an increase in the production and exports of skill-intensive products in advanced economies, while an opposite effect would occur in low-income economies that end up producing fewer skill-intensive goods and more labor-intensive goods for exports. This means that in developing countries, the price of the good that uses skills heavily will fall relative to the labor-intensive product. Demand for low skilled workers working in labor intensive industries would then increase in the South while demand for high skilled workers would fall. If wages are flexible, high-skilled workers employed in skill-intensive industries in developing nations would thus see their wages fall relative to lower-educated workers, reducing inequality in the South, while the North would see the exact opposite effect. If wages are sticky and inflexible due to resistance from high skilled workers, excess supply of those workers would cause unemployment of high skilled workers and excess demand for skilled workers in developing, low-wage countries. In short, the theory predicts *less* inequality within *developing* countries (thanks to rising wages and employment of low-skilled labor relative to high-skilled workers) and *more* inequality and unemployment of low-skilled workers in *advanced* economies. Wood's empirical observation further implied that low-skilled workers in developing countries and high-skilled workers in advanced countries benefited at the expense of their counterparts. Wood stated that nevertheless protectionism would hurt the low-skilled workers in developed countries that it was

meant to "protect," because it would slow economic development. Increasing the relative supply of high-skilled labor by investing in education was prescribed as a better countermeasure against rising inequality.[27]

While there was an overall consensus among economists that real wages of low and high skilled workers did indeed diverge rapidly at the same time as trade expanded in the 70s and 80s, the majority of empirical work examining the relationship between trade liberalization and income inequality using data from the 1970s and 80s did not find evidence that trade was the cause of income divergence. Rather, skill-biased technical or technological change was seen as the main driver of divergences in factor income and rising wage premiums for education (Bhagwati and Kosters, 1994). The main reason for these alternative views was the questionable premise of the conventional H-O model stating that the rising skill premium in developed countries is due to import competition from low-wage developing nations (Epifani and Gancia, 2008). To begin with, the share of trade with low-income countries was not large enough to have a relevant impact on developed OECD economies (Krugman 2000). A much larger share of trade consists of North-North trade, or trade between developed countries with similar factor endowments in terms of skilled and unskilled labor. For example, Grossman and Rossi-Hansberg (2012:593-594) have noted that the majority of intermediate inputs trade occurs among advanced OECD countries that are relatively homogeneous in terms of development.

[27] This remedy has been suggested by numerous other economists, such as López-González *et al.* (2015:34)

Recently, Epifani and Gancia (2008) suggested that even expansion of this intra-industry trade based on the New Trade theory between identical countries may increase the skill premium and relative demand for skilled workers. Contrary to the H-O model, the gains from trade in New Trade theory stems from being able to exploit increasing returns by selling to larger markets. Epifani and Gancia (2008)'s logic is that skill-intensive industries may show larger economies of scale effects compared to other industries, leading to falling relative prices, a disproportional increase in the demand for skill-intensive goods (based on some assumptions on consumption elasticity) and corresponding increases in the wages of high-skilled workers. If *intra*-industry trade can also contribute to rising inequality, the argument that trade cannot have had a significant impact on aggravating income inequality (since *inter*-industry trade based on the H-O theorem comprised only a low share in total world trade) becomes less relevant. Trade itself can be seen to have a "skill-bias" favoring labor with higher skills.

Nevertheless, most studies focusing on trade in general have attributed skill-biased technical change rather than trade as the main cause of diverging income distribution (among them Kruger 1993, Bhagwati and Kosters 1994, Acemoglu 1998, and Behar 2016). Berman, Bound, and Machin (1998), for instance, found strong evidence that skill-biased technological change was the main reason for the decrease in relative demand for less-skilled workers in developed OECD countries. Changes in methods of production that require high-skilled workers with creative or analytical skills and better usage of technology such as computers was seen to lead to higher wages for better

educated labor.

The empirical evidence that the relative wage of skilled workers increased in many different countries was also contrary to the "factor-price equalization" which should occur between advanced and developing nations according to the predictions of traditional variations of the H-O model. Following the H-O theorem, *developing* countries should not be seeing an increasing skill premium for their own domestic high-skill workers, but the reality is that within-country inequality has worsened in many developing countries as well as in the advanced nations (Epifani and Gancia, 2008).

However, the question of whether trade expansion may directly or indirectly aggravate the impact of skill-biased technical change on labor demand has been inconclusive. Many economists have recently argued that trade and skill-biased technical change can complement each other in impacting labor market inequality, and that the link between trade and technology becomes stronger in the context of GVCs (Bae *et al.*, 2013:27). As noted by Farole, Hollweg and Winkler (2018:6):

> "the standard 'trade versus technology' argument is probably a false dichotomy in today's world of globally-integrated trade and investment."

Coe, Helpman and Hoffmaister (1997), Muendler (2004), Acharya and Keller among many others have also suggested that technology can spillover to other countries or be transferred through trade. A recent influential paper by Autor, Dorn, and Hanson (2013) found that exposure to China's imports negatively affected local labor markets in the U.S. Interestingly, they found different labor market outcomes depending on whether

occupations could be computerized or not Farole, Hollweg, and Winkler (2018:6). In Autor *et al.* (2013)'s study, computerization was shown to substitute for routine tasks usually executed by lower-skilled labor, while skill-biased technical change complemented the creative and problem-solving managing skills of workers with higher educational attainment. As a result, medium skilled workers presumably moved to service jobs which rely more on face-to-face communication and are thus more difficult to be automated. This was said to contribute to a polarization of the labor market into low and high skilled jobs with a hollowing out of medium skilled jobs.

Regardless of the relative importance of skill-biased technical change versus trade, the paper's findings of job losses caused immense controversy in the U.S. and a number of additional empirical work on the labor market impacts of trade with China. A limitation of Autor *et al.* (2013) was that it did not adequately consider the role of export growth thanks to China. Feenstra, Ma, and Xu (2019) found that export expansion offsets the reduction of jobs due to import competition. Between 1991-2011, Feenstra *et al.* (2019:57) found a net increase of 379,000 jobs at the industry level, while they found a slight net decrease of 68,000 occupations at the community level. In a different angle, Antràs, Fort, and Tintelnot (2017) show that at the firm level, some U.S. firms that offshore to China can become more productive through lower costs, and therefore simultaneously source more inputs not just from China but also domestically.

1.2.3 Trade in Tasks and Wage Effects

The theoretical underpinnings of conventional inter-industry trade and intra-industry trade were mostly based on either the comparative-advantage-derived-from-different-factor-endowments literature or New trade theory based on economies of scale. Trade related to global value chains, on the other hand, is more closely linked to offshoring activities to other countries and trading intermediate goods and services. Thus, early attempts to examine the labor market impacts of GVC-related trade before the concept of GVCs and related indicators of participation became well-established were mostly focused on the impacts of offshoring, or trade in intermediate goods.

One of the defining characteristics of global value chains is the division of production into different activities or business functions. This concept of offshoring business activities in the more sociological GVC literature is akin to the concept of "trade in tasks," in the trade economics sphere, first proposed by Grossman and Rossi-Hansberg (2008). In the context of GVCs and trade in tasks, individuals in the same industry can be affected differently (Baldwin, 2009; OECD 2013:39). As this observation is captured in Grossman and Rossi-Hansberg's (2008, 2012) trade in tasks model, "trade in tasks" has been commonly used as the theoretical background of recent empirical studies on the distributional impacts of offshoring trade. Grossman and Rossi-Hansberg (henceforth GRH) attribute the rise of offshoring to the ICT and transportation revolution. For instance, the internet and cell phones allow teleconferencing and instant transmission of cross-border instructions on how to coordinate production and trade in parts and

components, allowing firms to exploit differences in factor costs across countries (2008:1978, 1984). Their model is based on Heckscher-Ohlin-type countries, but they do not examine trade in final goods, as is the conventional unit of analysis in the H-O model. Rather, the model focuses on trade in tasks, which the authors define as an exchange of "bits of value added in many different locations… performed by each factor of production" to produce a good or service (GRH, 2008:1978). This concept of task trade is closely related to intermediate goods trade, as intermediate goods are understood to be formed with "bundles of tasks" (GRH, 2012:595). Various tasks are assumed to have different offshoring costs depending on their *offshorability* (Blinder 2009). Some tasks, which GRH dub as "L-tasks," are more routine tasks easily performed by low-trained workers, while "H-tasks" are performed by high-skilled workers (*ibid.*,2008:1980). Whether a task is located abroad or domestically near headquarters is determined by weighing the advantages of locating certain tasks where local external economies of scale in performing that tasks exist, against the costs of having to monitor and coordinate distant activities abroad (*ibid.*,2012:595-598). Routine tasks that need less coordination may be more offshorable, whereas other tasks that need more interaction with managers may be better off located near headquarters (*ibid.*).

The most important implication of their model is that when the costs of offshoring fall, or some tasks become more easily offshored, a combination of three different effects must be considered to assess whether wages of workers will go up or down. The first issue to consider is whether the task being offshored is an L-task or an

H-task. If the costs of offshoring low-skill tasks decrease, three different effects are induced: a productivity effect, relative-price effect, and labor-supply effect (GRH, 2008:1979). The productivity effect refers to how firms' saved labor costs cause a similar effect as an increase in the productivity of those low-skilled workers who remain employed, and occurs when there are already some low-skilled tasks that are offshored (*ibid.*). Similar to "labor-augmenting technological progress," the productivity effect increases the demand and therefore wages of low-skilled labor (GRH 2008:1984). On the other hand, the relative-price effect and labor-supply effect are likely to put downward pressure on wages of low-skill workers when low-skill tasks are offshored. Similar to the Stolper-Samuelson effect, when there is more offshoring in labor-intensive sectors compared to high-skill-intensive sectors, falling relative prices of labor-intensive products and changing terms of trade may be hurt the wages of lower-skilled workers (*ibid.*, 2008:1984-1985). Meanwhile, low-skilled workers at home who find their jobs are offshored abroad become redundant, turning into excess labor that must be reabsorbed in the domestic labor market, which can also put downward pressure on their wages. At the same time, although there is no direct productivity effect, the relative price effect and labor supply effect caused by offshoring L-tasks affect high-skilled workers' wages positively in contrast with low-skilled workers and the marginal product of the high-skilled workers increases (*ibid.*, 2008:1990-1992). The surprising and perhaps even counterintuitive observation would be that the positive productivity effect can offset or even overpower the negative labor supply and relative price effects that put downward pressure on low-skilled workers, leading to a plausible increase in low-skilled workers'

wages when low-skilled tasks are offshored.[28] Whereas the impact on low-skilled labors' wages is ambiguous, high-skilled workers would clearly experience a boost in wages when their counterparts' jobs are offshored (Geishecker and Görg, 2013:127). This productivity effect is also considered by Antras *et al.* (2017), which was mentioned earlier in this chapter, although their analysis looks at how increased productivity at the *firm-level* can make firms source more inputs both from overseas and domestically.

All three effects affect low-skilled and high-skilled workers' wages in the *opposite* direction when it is the *H-tasks*, not low-skilled tasks which become offshored. Winkler (2013) states that goods or materials offshoring has been shown to increase the relative demand for white-collar workers and substitute for blue-collar jobs, whereas services offshoring may lead to medium and high-skill white collar jobs in advanced countries to being sent to low-wage countries. When high-skilled tasks are offshored, cost-savings and subsequent expansion of production occur relatively more in the high-skill-intensive sectors, leading to a productivity effect that increases the wages of high-skilled workers. If the economy is large enough to affect world prices, a relative price effect puts downward pressure on high-skilled workers, and there may also be a labor supply effect that hurts high-skilled workers but boosts the wages of low-skilled workers.

[28] The strength of these effects depends on the size of the economy, the number of tasks already offshored, the volume of task trade, and numerous other factors and assumptions. For example, Lopez-Gonzalez *et al.* (2015:13) point out that the productivity effect dominates when many tasks have already been offshored. They also state that the labor supply effect dominates when skilled labor comprises a large portion of total costs, or when low-skill tasks and high-skill jobs cannot be easily substituted in production.

In short, the wage effects of offshoring are determined by the combination and relative strength of the productivity, relative price, and labor supply effect, as well as the type of offshored activity. The power of each effect depends on the empirical context, hence leading to ambiguous predictions. Görg, Geishecker, Krieger-Boden (2011)[29] summarize the direction of each effect depending on the type of offshoring as in the following table.

FIGURE 2.12: THEORETICAL WAGE EFFECTS OF OFFSHORING

	Low-skilled workers	High-skilled workers
Offshoring low-skill activities		
Productivity increase of low-skilled workers	Wage ↑	-
Labor supply effect	Wage ↓	Wage ↑
Relative price effect on final goods	Wage ↓	Wage ↑
Offshoring high-skill activities		
Productivity increase of high-skilled workers		Wage ↑
Labor supply effect	Wage ↑	Wage ↓
Relative price effect on final goods	Wage ↑	Wage ↓

Source: Görg, Geishecker, Krieger-Boden(2011), based on Grossman and Rossi-Hansberg (2008)

GRH thus highlight the importance of empirical work in order to examine the magnitudes of each effect but acknowledge that it can only be possible by using trade in value added terms rather than the current gross trade data (2008:1996). Until quite recently, however, global value added trade data was unavailable, and empirical

[29] Holger Görg, Ingo Geishecker, Christiane Krieger-Boden, (24 December 2011) "Services offshoring increases wage inequality" Retrieved from (https://voxeu.org/article/services-offshoring-increases-wage-inequality)

literature aiming to examine the impacts of GVC related trade or offshoring had to resort to various proxies.

1.3 Traditional Proxy Measures of Offshoring Trade

1.3.1 Broad and Narrow Offshoring

Due to limitations in data, extant literature has used a variety of proxies to measure participation in global value chains at the aggregate level beyond tear-down case studies of specific products. International fragmentation of production and GVC trade is closely related to offshoring activities of firms. According to the OECD (2013:18), "the cross-border aspect of offshoring[30], i.e. the sourcing of goods and services from abroad, determines the increasingly global character of value chains." Thus, attempts to measure offshoring activities are closely linked to proxying GVC participation.

According to Feenstra (2016:1,10), one of the earlier "first generation" statistics to measure offshoring was the "share of imported intermediate inputs in costs of total (non-energy) intermediates used by an industry," which was proposed and used in Feenstra and Hanson (1996, 1999). Feenstra and Hanson (1999:924-925) used this imported import share as an "offshoring index" that distinguishes broad foreign outsourcing versus narrow international outsourcing. Using these indices, they found that global sourcing

30 According to the OECD (2013:18), technically speaking, "Offshoring includes both international outsourcing (where activities are contracted out to independent suppliers abroad) and international in-sourcing (the transfer of particular tasks within the firm to a foreign affiliate)."

of intermediate inputs steadily increased. Skill-biased technical change or computerization was shown to explain 35%-75% and offshoring 15%-40% of the increase in wages of non-production workers over the 1979-1990, depending on the model specification. The findings demonstrated that *both* foreign outsourcing and technology explained part of the increase in relative wages of high-skilled white collar workers (Feenstra 2016:11-12).[31]

The following is Feenstra and Hanson's offshoring index for an industry *i* as explained by Todo (2013:254-255):

$$\sum_j (share\ of\ good\ j\ in\ total\ purchases\ by\ industry\ i) \times (share\ of\ imports\ in\ total\ consumption\ of\ good\ j)$$

$$= \sum_j \left[\frac{Input\ purchases\ of\ good\ j\ by\ industry\ i}{Total\ input\ purchases\ by\ industry\ i}\right] \times \left[\frac{Imports\ of\ good\ j}{Domestic\ consumption\ of\ good\ j}\right]$$

According to Geishecker and Görg (2008:248), the narrow definition of offshoring "captures only an industry's imported intermediate inputs from the *same*[32] industry abroad", whereas wide outsourcing covers "all imported intermediate manufacturing goods of an industry." The latter, in other words, looks not just at imports from the same industry but from other industries as well Winkler (2013:79). According to Choi *et al.* (2015), this offshoring index can be considered as a measurement of what needs to be imported in order to produce (Baldwin, R. and J. López-González (2014)). Amiti and

[31] According to GRH (2008:1991), Feenstra and Hanson's early study focuses primarily on the labor-supply effect within the GRH framework.

[32] No italics in original text

Wei (2009) extended Feenstra and Hanson's offshoring index (which originally focused on material offshoring) to examine the effects of service offshoring.

Various versions of these offshoring indices have been used in empirical studies, including Geishecker and Görg (2008, 2013), Görg and Görlich (2012), Geishecker, Görg and Munch (2010). According to Amador and Cabral (2015:108), many of these more recent empirical studies on labor market impacts suggest a skill bias toward skilled labor in advanced economies. Nevertheless, the time period, units of analysis, and methodologies show conflicting results.

Geishecker and Görg (2008) combined industry-level offshoring data with individual worker panel data from Germany and found evidence that offshoring may adversely affect low-skilled workers' wages. Firm level data on Italian manufacturing firms also showed evidence of that offshoring contributed to an increased relative demand for high-skilled workers (Antonietti and Antonioli 2011). Tomiura, Ito, and Wakasugi (2013) indicated that offshoring may lead to changing composition of firms' workforces, by employing more high-skilled workers compared to low-skilled workers. Todo (2013), examining data from 2006 to 2009 on small and medium sized firms in Japan, did not find clear evidence that offshoring reduced employment, but found evidence that the expansion of *material* offshoring improved firm-level productivity and an association with skill upgrading, or a larger proportion of labor with tertiary education. On the other hand, *service* offshoring did not show a clear positive productivity effect, contrary to most other developed economies, which Todo (2013) suggests may be due to

the “unique linguistic, cultural, and institutional” characteristics of Japan leading to difficulties in finding suitable service offshoring partners. Besson, Durand, and Miroudot (2013) examined the relationship between offshoring, imports, and the profits of firms in France between 1990 to 2009. The directions of labor market outcomes showed heterogeneous results depending on the industries in question, with increasing employment in some industries, decreasing jobs in others, and many showing results somewhere between the two extremes. The study also suggested shifts of labor from manufacturing to services, demonstrating that although 762,000 manufacturing jobs disappeared between 1990 to 2009, 1,752,000 new jobs were created in services. Winkler (2013) studied the impact of services offshoring on white-collar workers in Germany and found results akin to the theoretical implications of the Grossman and Rossi-Hansberg (2008) model. The positive productivity effects accruing from offshoring skill-intensive tasks were offset by negative labor supply and relative price effects, leading to reduced relative demand for white-collar workers in comparison to blue-collar workers. Her findings contrasted with those of Crino (2012), who found evidence of a skill-bias favoring high-skilled workers in service offshoring, or a relative increase in employment of high-skilled jobs relative to lower-skilled occupations. Crino (2012) combined occupational data with three different levels of educational attainment and a different proxy for services offshoring, which underscores that methodological differences in measuring can lead to different empirical results. Meanwhile, Baumgarten, Geishecker and Görg (2013), examined routine and non-routine tasks in German manufacturing and found that the magnitude of the negative effects of offshoring on wages changed

depending on whether looking at only *within*-industry variation or cross-industry changes (allowing labor to shift industries).

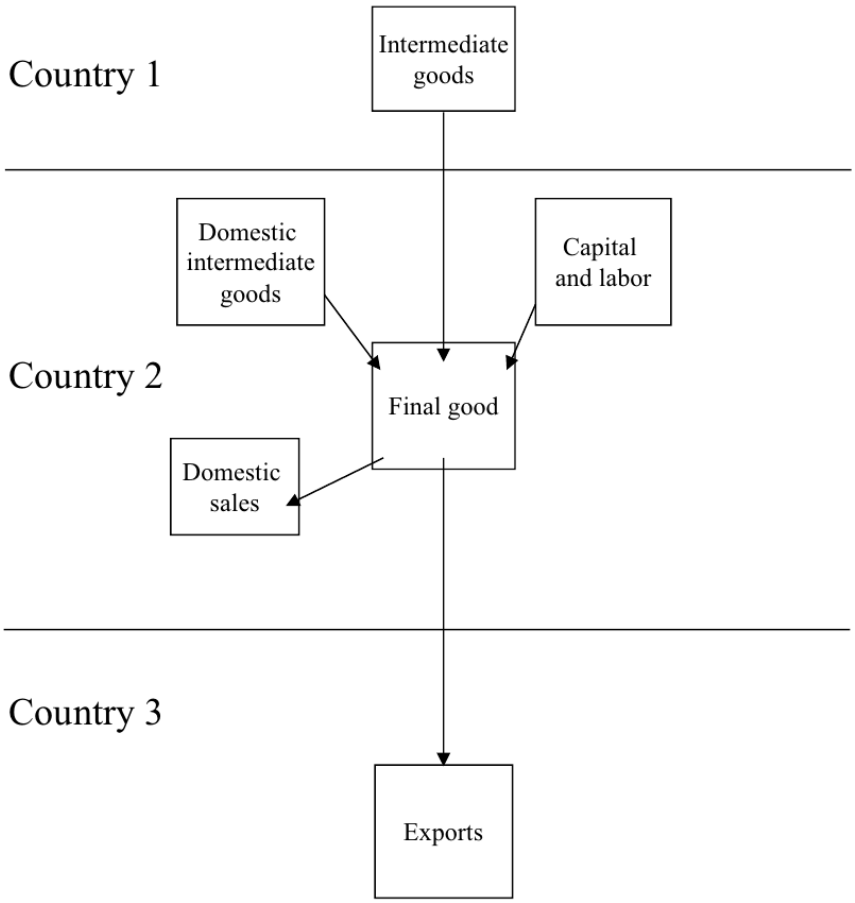
Although these first generation offshoring indices contributed to the creation of a rich empirical literature looking into the labor market impacts of overseas outsourcing, they were not without drawbacks. One of the key assumptions of this index is the so-called "proportionality assumption" (Feenstra 2016). The ratio of how much of an intermediate input (either a good or service) is imported from overseas or domestically-sourced by any one industry to be used in production is assumed to be equal to that of the whole country's imports of this good or service (Todo 2013:254-255, Winkler 2013:80). Following this logic would mean that "steel imported into the automobile industry uses the same ratio of imports to domestically-sourced inputs as does the economy as a whole (Feenstra 2016:10)." However, as Todo (2013: 254-255) and many others point out, this assumption is not realistic. Moreover, Choi *et al.* (2015) state that the offshoring index does not clearly distinguish foreign outsourcing from domestic outsourcing, and that this measure is closer to what Baldwin and López-González(2014) called "imports for production" rather than "imports for exports" produce.

1.4 Second Generation Offshoring Statistics

Partly to deal with some of these problems, Feenstra (2016) states that "second generation" offshoring proxies such as the domestic or foreign "value-added in exports" were constructed, using the aforementioned international input-output tables in order to

overcome the problems of measuring imported inputs in the presence of multiple cross-border production linkages (Hummels *et al.* 2001, Johnson and Noguera 2012, Koopman *et al.* 2014). These new generation statistics are better-suited for looking at the degree of integration into global production networks, as they were early attempts to more accurately measure GVC-related trade.

FIGURE 2.13: VERTICAL TRADE AS SHOWN BY HUMMELS, ISHII, AND YI (2001)



Source: Hummels, Ishii, and Yi (2001)

1.4.1 Vertical Specialization

One of the first "second generation" indicators in the foreign value added in export literature was pioneered by Hummels, Ishii, and Yi (2001). They constructed a measure of "vertical specialization (VS)," which they state was first coined by Balassa (1967). Their measure specifically looked at the proportion that offshored imported intermediate goods and services contributed to in a country's *exports*. Contrary to the earlier offshoring index, VS is a measure of what Baldwin and López-González (2014) call *imports for exports*. Specifically Hummels *et al.* (2001:78-79) narrowly define their measurement for country *k* and product or industry *i* as in the following equation:

$$VS_{ki} = \left(\frac{Imported\ intermediate\ inputs}{Gross\ Output}\right) \times Exports$$

Which can be re-arranged to

$$VS_{ki} = \left(\frac{Exports}{Gross\ Output}\right) \times Imported\ intermediate\ inputs$$

The left side, (imported intermediates/gross output) * exports is the imported input content of exports. Using these definitions, Hummels *et al.* (2001) then point out that the VS for a country *k* is just the sum of all VS for all industries:

$$VS\ share\ of\ total\ exports \equiv \frac{VS_k}{Exports_k} = \frac{\sum_i VS_{ki}}{\sum_i Exports_{ki}}$$

The reasoning behind this definition given by the authors is to emphasize sequential value added to a good in its production process, which involves the crossing of two or more countries and international borders. In other words, the goal was to focus more

specifically on vertical trade that characterizes global supply chains.

Using industry-level data on imported inputs from the OECD Input–Output Database (which included economies that accounted for 60% of world trade at the time of their writing), Hummels *et al.* (2001) found that growth in VS accounted for up to 30% of the growth in gross world exports between 1970-1990. The concept of vertical specialization also highlighted how tariff costs become amplified when there are multiple stages of production across many borders (Yi, 2003). Another contribution of the VS index was that subtracting it by 1 gives an easy calculation of the domestic value-added contribution in exports.

The VS, or foreign value added in exports, may be a better characterization of GVC-related supply chain trade, but is not free from limitations. Two technical assumptions may not be realistic: first, Hummels *et al.* (2001) assume that both production for exports and production for domestic consumption use the same proportion of imported inputs (Koopman, Wang, and Wei (2014). The reality is that an increasing number of countries engage in "export-processing trade" in special export zones, where this first assumption breaks down. According to the OECD (2013:142-144) , WTO and IDE/JETRO, (2011), export processing zones (EPZ) are specially designated areas in emerging economies such as China that have the specific goal of providing incentives for foreign investment such as low taxes, with the goal of processing goods to be re-exported. These areas would have a much higher content of foreign inputs compared with other areas in an economy that would produce mainly for domestic consumption.

The second assumption of the VS index is that economies' imports contain only foreign value-added, or to state the opposite side of the coin, that there is no domestic value added in imported inputs. In reality, GVCs are characterized by trade in inputs crossing borders multiple times, meaning that domestic value added embodied in a component exported upstream in the GVC may return later on in a more downstream stage when foreign inputs are again imported for further processing. To illustrate, one can conceive a smartphone assembled in China and exported to Korea that includes a semiconductor memory chip input made in Korea, which in turn used silicon imported from China. From China's perspective, the semiconductor that was imported from Korea as an input would already have some Chinese domestic value added included (in the form of silicon). We can see here that VS is inadequate in dealing with double counting issues that arise due to imported intermediates already containing value added from third countries (including the home country itself). For example, Ahmad (2013:97) mentions that in Korea's electronic industry, intermediate inputs imported from overseas already contained 5% of Korean value-added that was added in previous stages of production.

Perhaps a more pressing issue is that the earlier VS only captures a subset of GVC activity (OECD 2013:25). Countries participate in upstream links of GVCs by buying imported inputs, but they also participate in more downstream linkages by selling intermediates to other countries. Hummels, Ishii and Yi (2001) did refer to this other side of GVC activity as VS1, but they did not formally define it mathematically as they did with the buy-side measure of GVC participation. A subset of VS1 (VS1*) was formalized

later on by Daudin, Rifflart, and Schweisguth (2011). Following the suggestions of Koopman *et al.* (2010, 2014), these two measures are refined and combined to provide a more total measure of GVC participation that is provided in the OECD-WTO TiVA which will be discussed later in the chapter and will be used the main independent variable of interest in this study.

1.4.2 Value Added to Exports (VAX) Ratio

Again, an improvement of this earlier measure of vertical specialization was proposed by Johnson and Noguera (2012) defined as the value-added to gross-value ratio of exports (VAX ratio), which allows for scenarios where countries re-import domestic value added as they import inputs for domestic consumption. It is based on the construction of global input-output tables that combine national input-output tables with bilateral trade data, jointly considering source and destination economies (Johnson 2014). This meant that double counting no longer became an issue. The VAX ratio is an inverse measure of GVC participation, where the lower it is, the higher the foreign content in exports. A source country *i*'s value added to export ratio or VAX ratio with respect to destination country *j* at time *t* in sector (industry) s can be defined as follows[33]:

[33] Author's adaptation of Johnson and Noguera (2012) based on Chung (2016)

Definition 1.

$$\text{Value Added Exports} = VAX_{ijt}(s) = r_{it}(s)y_{ijt}(s))$$

$$\text{Aggregate or Total Value Added Exports} = \sum_s VAX_{ijt}(s)$$

Definition 1 refers to "the total value added produced in sector *s* in source country *i* and absorbed as foreign final demand in destination country *j*." Total value added produced in *i* and absorbed in *j* is then the sum, which is shown as Total Value Added Exports.

Definition 2.

$$\text{Sector-Level Bilateral Value Added Export Ratio} = VAX\ ratio_{ijt} = \frac{VAX_{ijt}(s)}{x_{ijt}(s)},$$

Definition 2 states that dividing Value Added Exports by Gross Exports $x_{ijt}(s)$ gives the $VAX\ ratio_{ijt}$.

The *aggregate* VAX ratio (rather than the sector-level VAX ratio) is the most appropriate for measuring GVC participation, which will be discussed in more detail later in the robustness checks section of this study. Intuitively, in the past, when the world saw little GVC trade, exports contained almost 100% domestic value added since there would be few foreign inputs sourced, which would correspond to a high VAX ratio, while in today's world of fragmentation of production, many inputs would be sourced overseas, leading to a lower VAX ratio. The VAX ratio has provided many new empirical implications for macroeconomics and trade research. Johnson and Noguera (2012) found

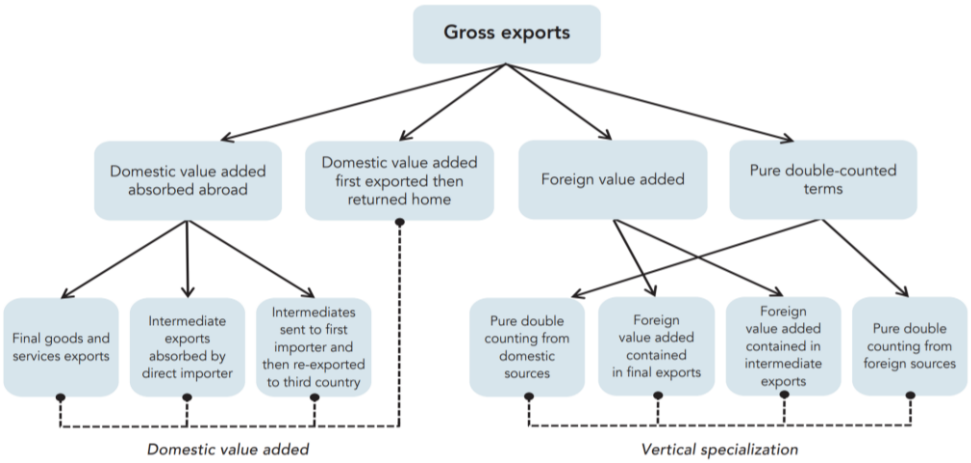
that the VAX ratio has declined significantly in the past decades, particularly after 1990, when offshoring of manufacturing, the IT revolution, integration of the EU, and trade liberalization all contributed to the rapid expansion of GVCs. Whereas global value-added exports accounted for 85% world gross exports in the 1970s and 80s, it now only accounts for 70-75% (Johnson 2014). Furthermore, manufacturing trade becomes less important while services trade becomes more significant, further highlighting the importance of services in GVCs.

Another key finding of Johnson and Noguera was that the US-China trade deficit decreases in value added terms compared to gross trade imbalances, while Japan and Korea's surpluses against the US become even larger. For instance, Japanese value-added exports to the US are 7% larger than gross exports, leading to a 33% higher trade surplus against the US (*ibid.*, 2012, Johnson 2014:126), On the other hand, the US-China deficit in 2004 becomes 30-40% smaller when measured through value-added exports (Johnson and Noguera 2012). At a broader scale, they find evidence of the triangular trade among Asian countries with China as a supply hub ultimately exporting to the US, by seeing that the increase of trade surpluses of Korea, Taiwan and Japan and decrease of surpluses of Australia and Singapore against the US add up to the fall in the US-China deficit. Thus, exports measured in value added terms showed evidence that many countries "indirectly" export value added through other countries.

1.5 The GVC Participation Index[34]

Koopman, Wang, and Wei (2010, 2014) provided an integrated framework that included all of these previous GVC measures (VS, VS1, VAX) as combinations of decomposed components in an economy's gross exports.

FIGURE 2.14: GROSS ACCOUNTING FRAMEWORK



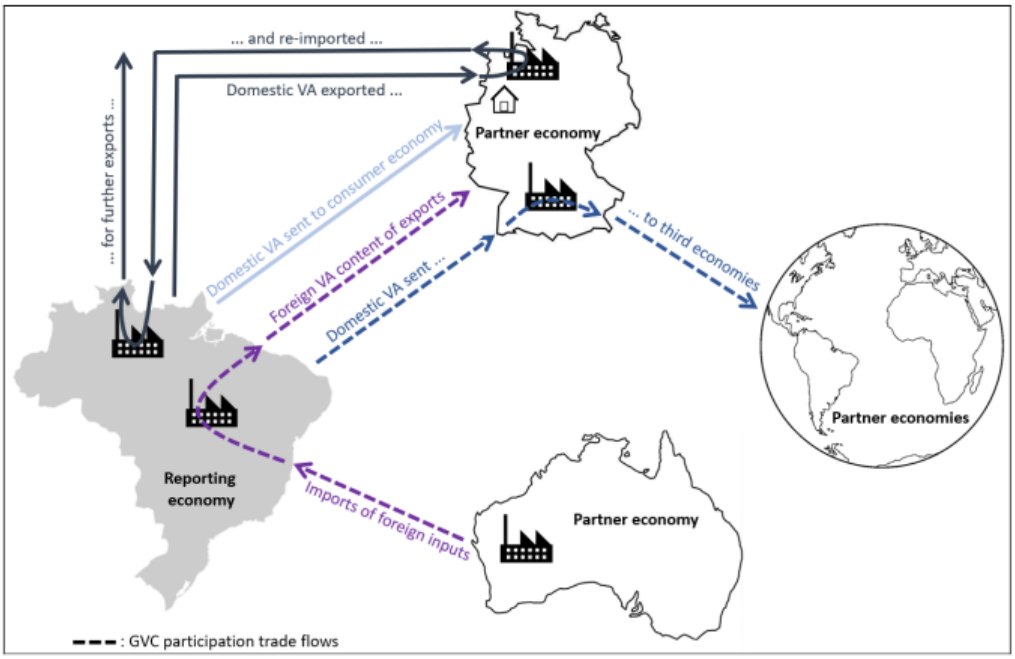
Source: Satoshi Inomata (2017)'s adaptation based on Koopman, Wang, and Wei (2014, 2016)

As mentioned earlier, one problem with the vertical specialization index proposed by Hummels *et al.* (2001) was that it only looked at the upstream, or backward linkages of GVC trade (foreign imported inputs used in exports to other countries). VS1, which shows the forward linkages or downstream participation in GVCs. Based on Koopman

[34] See OECD (2013) "Measuring Trade in Value Added" for technical details on how the backward and forward GVC participation indices can be calculated from input-output tables. De Backer and Miroudot (2013:46) as well as Lopez Gonzalez *et al.* (2015:60-61) also provide a shorter summary

et al. (2014)'s gross accounting framework, researchers[35] have recently created a total measure of GVC participation that sums VS with VS1 to provide a more complete picture of GVC participation. The forward linkage-based VS1 based on the perspective of upstream producers, is henceforth referred to as "Forward GVC Participation," whereas the backward linkage-based viewpoint of downstream users or consumers engaged in GVC trade is dubbed as "Backward GVC Participation."

FIGURE 2.15: BACKWARD AND FORWARD GVC PARTICIPATION



Source: WTO (2019b) "'Trade in Value-Added and Global Value Chains' profiles Explanatory notes" 2019 version

[35] López-González (2012) initially dubbed the terms "backward linkage vertical specialization (VS-B)" and "forward linkage vertical specialization (VS-F)" whose sum was "total vertical specialization" - essentially the same concept as backward, forward, and total GVC participation

1.5.1 Backward Participation (Foreign Value Added in Gross Exports)

The backward participation index or ratio is defined as the foreign value added embodied in gross exports and is expressed either as a share or percentage. Based on the former vertical specialization measure, it describes the degree that an industry in a country sources imports of foreign intermediate inputs in the production of its exports of intermediate or final goods and services. Thus, backward GVC participation is essentially the demand or buy-side in GVCs (OECD 2013, De Backer and Miroudot 2013, UNCTAD 2013). It corresponds to the purple arrow shown in the figure in the previous page. An example of backward participation would be the Japanese value added of imported Japanese chemicals used in Korea's exports of semiconductors, which are exported to China and used in the assembly of smartphones. Likewise, China's imports of OLED screens from Korea to be used in TVs assembled and exported to the United States would comprise China's backward participation in GVCs. Empirically, small open economies tend to have more foreign value added in exports, because they are more likely to lack natural resources or suppliers of other key inputs within their domestic borders (De Backer and Miroudot, 2013:12, UNCTAD 2013, OECD 2018). Economies that mostly rely on manufacturing are likely to have higher backward participation indices compared to those that specialize more in services. Changes in the prices of commodities such as oil can also influence the backward participation indicator, since downstream economies would be shown as importing more foreign value added if they must purchase their inputs at higher prices (OECD 2018).

1.5.2 Forward Participation (Domestic VA in Exports to Third Countries)

On the other hand, the forward participation index is defined as the proportion of domestic value added that is sent to third economies, divided by gross exports. It should not be confused with domestic value added in gross exports, as that would just be a mirror version of backward participation, or one minus VS. It specifically refers only to domestic value added that is contained in intermediate inputs exported to a second country, and then re-exported to another third nation, embodied in some other good or service further downstream in the value chain. Thus, forward participation can be seen as a supply or sell-side indicator of GVC trade. As shown in the blue arrow in the previous figure, forward participation shows how much of a country's exports are used as foreign value added in other economies' exports (WTO 2019). Going back to the previous example of an ICT supply chain, the value added of Japan's exports of chemicals to Korea which are used for Korea's semiconductor *exports* would be part of Japanese forward participation, but the same chemicals used in the production of semiconductors made for Korean domestic consumption would not be calculated as part of Japanese forward participation.

1.5.3 Total GVC Participation

Total GVC participation is simply the sum of backward and forward participation.[36]

[36] This is under the assumption that the backward and forward participation indices are already expressed as a share of gross exports. If they are not, one must divide the sum by total exports

By incorporating both the upstream and downstream viewpoints of GVC-related trade, total GVC participation is better suited to accurately describing the extent that an economy or industry participates in global value chains than previous measures. For instance, raw material or energy exporters such as Australia in the early stages of the value chain would obviously have mostly domestic value added in their exports, and thus a low vertical specialization (backward participation) index (OECD 2013:25, UNCTAD, 2013:126). These countries would on the other hand have a high forward participation ratio and adding the two to find total participation gives a more balanced perspective on the aggregate GVC activities of different countries and industries. Meanwhile, some industries participate disproportionately more in GVCs. Services are more difficult to slice up into different stages and are less fragmented in terms of their GVC participation ratios (even though they play a crucial role in composing the value added of other industries). On the other hand, chemical refining, steel, and other heavy industries that must import large amounts of raw materials such as coal, iron, or oil have high backward participation ratios, especially if they are located in countries such as Korea and Japan which lack natural resources. Industries based on modular products which use components produced through international codified standards, such as high-tech electronics and motor vehicles are also heavily integrated in GVCs due to the ease with which they can be produced and sourced from different destinations (Gereffi, Humphrey, and Sturgeon, 2005:97; OECD 2013:27). Using the GVC participation indices can therefore show the degree that different countries and industries participate in upstream or downstream activities.

In this vein, by exploiting the advantages of being able to combine and differentiate the impact of forward and backward linkages with this more accurate barometer of GVC integration, this study provides important insights into the empirical literature in comparison with previous studies that resorted to using GVC trade proxies such as imports of parts and components or just the foreign value added in exports (vertical specialization). Indeed, it seems that the impacts on labor markets differ considerably depending on which type of GVC participation is analyzed.

Nevertheless, even when GVC participation is decomposed into forward and backward participation, qualitative characteristics such as industrial structure as well as the composition of skills and technology embodied in each country-sector's exports and imports may imply different labor market impacts among countries with similar degrees of GVC participation. To illustrate, even if Japan and Saudi Arabia hypothetically had an overall similar level of forward participation, the intermediate inputs exported would be considerably different (Japan's forward participation is often technologically sophisticated intermediate goods rather than natural resources, whereas Saudi Arabia's forward participation would be its oil and natural gas used as imported inputs in the exports of other countries).

1.5.4 Data Limitation: Absence of Business Functions and Tasks

This highlights one of the main limitations of value added trade statistics: they do not allow an accurate description of the specific *tasks* and *functions* that are carried out in each stage of the value chain (Timmer, Miroudot, and de Vries, 2019). In other words,

even though value added trade is much better than traditional trade statistics in describing the characteristic of international fragmentation of production, it is not granular enough to describe the "trade in tasks" mentioned by Grossman and Rossi-Hansberg (2008, 2012). If one recalls the definition of global value chains provided by Kaplinsky and Morris (2001:4) and Gereffi and Fernandez-Stark (2016) near the beginning of this thesis, GVCs are divided into *activities* or business functions of production, starting, for instance, at product conception or R&D. Lanz *et al.* (2011), argue that the concept of bundles of tasks used in production is one of the key steps to integrating contemporary trade economics with the more sociological GVC literature of Gereffi and others. Unfortunately, contrary to the definition of GVCs being stages of business activities, data on trade in value added tracks the beginning of GVCs at the industry level rather than tasks (for instance, raw material extraction). One problem is that when services are produced in-house by a manufacturing firm, they are recorded as manufacturing output, whereas if they are outsourced via arms-length transactions to another firm that is specialized in providing services, the same services become classified as services output. As shown in the following chapter, this can particularly affect analysis of Korea's exports, because the primary activity of most Korean large conglomerates known as *chaebols,* is manufacturing. These conglomerates tend to provide most of their services in-house, contributing to the underestimation of services value added in Korea's exports. Furthermore, it is very difficult to say with value added trade statistics on whether an increase in backward or forward participation is related to industrial upgrading, as this will depend on the context. For instance, if firms upgrade by focusing on new core

competencies and outsource certain upstream activities in which they are less productive overseas, they will end up importing more foreign value added (OECD, 2018)[37]. On the other hand, if they move along the smile curve from manufacturing to higher value added activities such as R&D, there will be less need to engage in foreign outsourcing (*ibid.*) With this limitation in mind, Timmer, Miroudot, and de Vries (2019) have recently published a paper arguing for the need to develop a third generation of trade statistics that goes beyond value added trade, which they dub "functional specialization (FS)." Nevertheless, such a comprehensive database in FS is currently unavailable. Therefore, the remainder of this section considers some mechanisms that GVC participation may affect the demand and supply for skills. The theoretical considerations presented in this section, along with the qualitative analysis of Korea's GVC trade in the following chapter, will be used to construct hypotheses on the impact of different types of GVC participation on wages, even if the value added trade data does not provide specific detail on the business activities embodied in trade. The qualitative analysis of Korea's trade, specialization, and development path as well as previous empirical findings should allow better inferences on what kind of activities are being offshored abroad (or received) through Korea's GVC-trade.

1.6 Additional Labor Market Impacts of GVC Participation

GVC-trade is by definition a type of "trade." Thus, all the aforementioned hypothetical

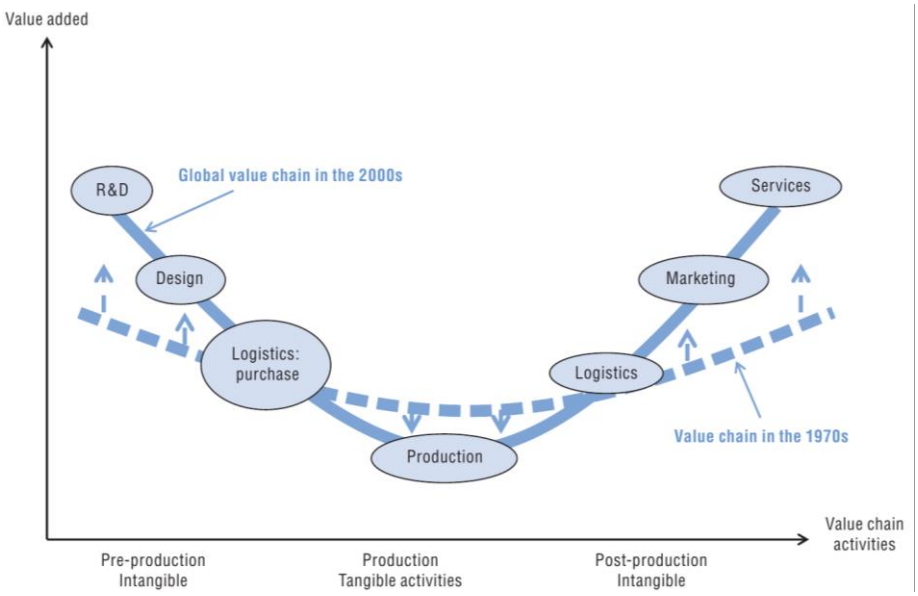
[37] OECD (2018) "Trade in Value Added (TiVA) Indicators Guide to Country Notes", December Ver,

and empirical gains from as well as potential distributional impacts from conventional trade can logically be inferred to be related with global supply chain trade as well. The key focus then is the potential differences that it has with traditional types of trade. As mentioned earlier, many studies have examined the links between GVC participation, development, and industrial upgrading. The insights from these studies, such as how new domestic backward linkages are formed, how the composition of workers employed in various sectors is transformed, how services become more important, and as a result of all of these changes, how productivity is enhanced through GVCs, provide some theoretical background to how GVC participation itself may impact labor markets, with some factors similar to conventional types of trade and some aspects either amplified or even different from traditionally identified channels between trade and labor market outcomes. The role of shifting to different value-adding activities on the "smile curve," on a product level value chain, for instance, may have important implications for labor markets at the more macro-level. Moreover, GVCs are characterized mostly by trade in intermediate goods and services which embody significant amounts of foreign technology and offshored tasks. Thus, GVC trade may influence the complexity of industrial organization in ways that are more beneficial for skilled rather than less-skilled workers, such as increasing the need for complementary service inputs (Dollar, 2019). However, studies specifically examining the role of heterogeneous GVC participation at the industry level (that is, forward and backward participation) directly on labor markets have only very recently been introduced to the empirical literature. These studies are few in number and have also shown directly conflicting results in some cases.

1.6.1 The Smile Curve and Industrial Upgrading

The smiling curve is said to have been coined in the early 1990s by Stan Shih, the founder of the Taiwanese technology firm Acer, well known for its computers (Shih, 1996).

FIGURE 2.16: DEEPENING OF THE SMILE CURVE



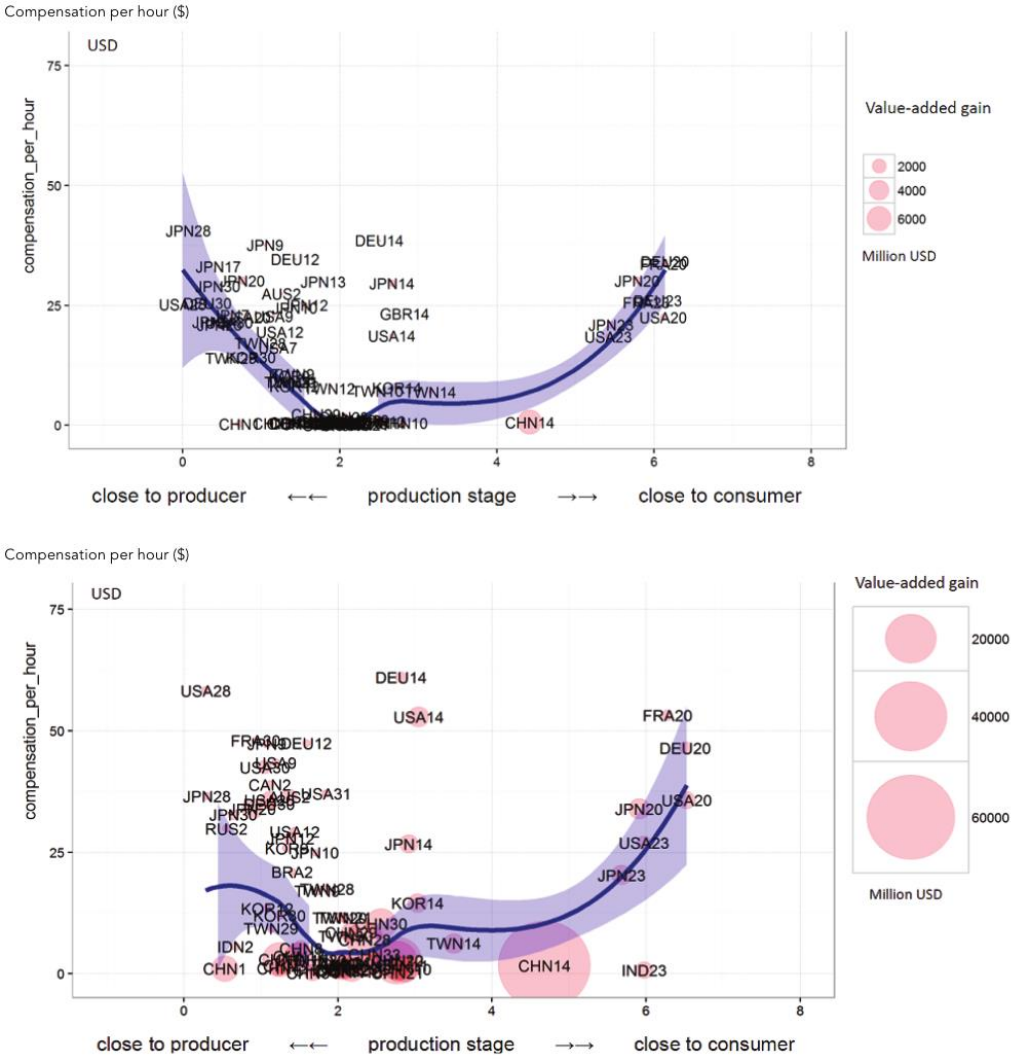
Source: OECD (2013:214) based on Shih (1996) and Baldwin (2013)

The main observation behind the smiling curve is that the beginning and final stages of the value chain focusing on intangible activities seem to capture more value added compared to tangible activities such as fabrication or assembly located in the middle of

the value chain. Business management theory suggested that the smile curve "deepened," with even less value added going to final assembly and production activities compared to the 1970s, perhaps at least partly because the increase of offshoring to developing countries has been concentrated in the production stage (Baldwin 2013). The implication for GVC studies is that if the share of value added going to manufacturing activities has decreased, exporting manufactured goods might not automatically translate into full scale industrialization as was the case in the past (*ibid.*). For instance, the fact that Vietnam assembles Samsung Galaxy phones (exporting high-tech goods) is not a sufficient criterion to claim that the country has achieved advanced-nation status (*ibid.*). In short, exporting high-tech goods might simply reflect the fact that a country is located at the end stage of assembly in international supply – thus capturing only a small amount of value added (*ibid.*).

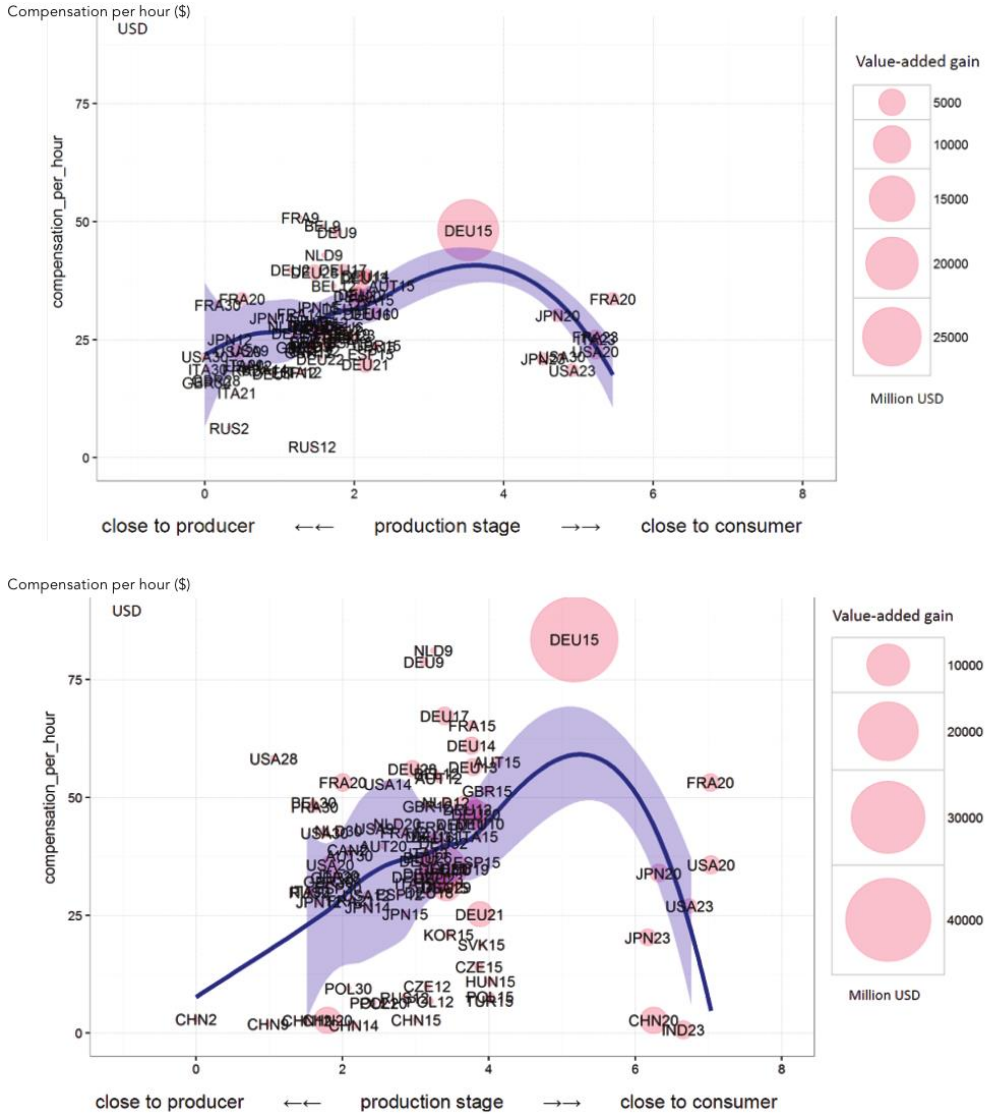
The concept of the smile curve provided useful implications for GVC studies, but empirical studies were focused mostly on product-level or firm-level case studies akin to the teardown report by Dedrick *et al.* (2010) regarding the iPod. A very recent study by Degain, Meng, and Wang (2017:54) and Li, Meng, and Wang (2019:22) has finally examined the implications of the smile curve at the national economy level, using measures of value added trade and indicators of the length between consumers and producers.

FIGURE 2.17 ESTIMATED SMILE CURVE FOR CHINA'S EXPORTS OF ELECTRICAL AND OPTICAL EQUIPMENT, 1995 AND 2009



Sources: Degain, Meng, and Wang (2017: 55), Meng, Ye, and Wei (2017)

FIGURE 2.18: ESTIMATED SMILE (FROWN) CURVE FOR GERMANY' AUTOMOBILE EXPORTS PRODUCTION, 1995 AND 2009



Sources: Degain, Meng, and Wang (2017: 57), Meng, Ye, and Wei (2017)

Using estimates calculated from the World Input-Output Database, Degain, Meng, and Wang (2017:54-57) found that China's ICT exports followed the logic of the deepening smile curve in 1995 and 2009, with ICT sectors in countries such as Germany, Japan, and Korea located upstream in prefabrication stages as well as postfabrication services capturing a large portion of value added and having higher labor compensation per hour, similar to the teardown study by Dedrick *et al.* (2010).

On the other hand, they also found that the logic of the smile curve does not apply to all industries: smiling curves can be inverted, or "frown," as in the case of the German auto industry (*ibid.*) German labor in car manufacturing received higher compensation than other stages, which Degain, Meng, and Wang (2017:58-59) suggested may be due to the transformation of German auto industries to mass customizers closely linked to consumers. The conclusion is that although the smile curve provides interesting insights into the mechanisms of how changing value added captured by certain stages of production may affect labor compensation, results differ depending on the countries or industries examined, with no clear causal relationship heading in one direction.

This does not mean that the idea underlying behind the smile curve is not of any use. The smile curve is also linked to the concept of industrial upgrading, or the shift to higher value added activities that carry out more sophisticated tasks. If countries increasingly specialize in business functions with higher value added, of specialization in entire industries (Bacchetta and Stolzenburg 2019:47). This is because higher value added tasks tend to be high-skill intensive, whereas lower value added stages of

production are labor intensive. Although traditional *industries* such as textiles have also been characterized as "labor-intensive" and some sectors such as electronics were dubbed "high-skill-intensive," both types of industries necessarily needed a mix of both types of workers if they were located entirely in one country. In the past, in order to export computers, Korean firms needed to domestically hire large amounts of low-skilled labor who assembled parts in factories while at the same time employing high-skilled engineers and managers. This is still partly true, but specialization in GVCs and offshoring has led many of the low-skilled tasks to be offshored to developing countries. The exact opposite is Vietnam: in the past, the fact that a country was exporting high-tech mobile phones meant that it had reached an important threshold of advanced industrialization, but the reality today is that Vietnam is specialized in the majority of low-skill-intensive activities across many industries, including both traditionally low and high-skill sectors. Thus, if GVC trade induces countries to upgrade along the smile curve, it may amplify the relative demand for high skilled workers more than in comparison with traditional trade that is based on specialization in industries. Furthermore, the qualitative characteristics of upgrading can therefore be linked to some extent with the degree of participation in GVC-related trade. Baldwin (2013) and Lopez-González (2012) noted a correlation between the degree of backward and forward participation with the income level of countries. The two indicators have mirror images: countries use more foreign value added in exports until they reach a threshold income level, and then backward participation decreases in an inverted U-shape. Baldwin (2013:52) pointed out that China's imported inputs rose as it upgraded from textiles to electronics and

machinery assembly, while Finland, which has divested of most manufacturing activities, has less foreign value added in its exports. On the other hand, forward participation tends to have a U-shape, decreasing up to a certain point but then increasing as development continued. Countries such as Japan and Germany engaged in higher forward participation as they exported sophisticated parts and inputs (*ibid.*) In relation to this concept is the so-called "flying geese model (Baldwin 2013:36)."

According to Baldwin (2013:36), East Asian economies have benefitted from a continuous regional agglomeration or clustering of industries that has acted as a continuous source of attraction for manufacturing activities. Even when wages rise, labor-intensive activities may begin to depart, but they go to nearby locations which can exploit the benefits of the clustered hubs. In the meantime, the original country with the low-wage advantage tends to upgrade its industries further upstream in the value chain, such as from assembly to producing more sophisticated parts, to creating their own brands and products. This continuous process of upgrading, higher wages, and offshoring of manufacturing activities to nearby developing economies in the region with low unit-cost has been described as a "flying geese pattern." Throughout the decades, countries that started from exporting labor-intensive goods such as textiles and climbed up the industrial ladder were Japan, Korea, Taiwan, Hong Kong, Singapore, and recently China and a host of Southeast economies including Thailand, the Philippines, Indonesia, Malaysia, and Bangladesh (Baldwin 2013, 50). Rising wages in China are now encouraging the continuation of this flying geese pattern to new low-wage economies,

such as Vietnam (*ibid.*).

Recently, China and many other upper middle-income countries' backward participation ratios have indeed recently declined (Li, Meng, and Wang, 2019:14). This has been attributed to even further industrial upgrading, as imported intermediates from advanced nations are substituted with domestic backward linkages and suppliers (Li, Meng, and Wang, 2019:15). If this U-shape tendency is true, the limitations of value added trade statistics in showing the composition of business functions and activities may pose a problem in trying to establish some causal relationship between the degree of GVC participation and productivity growth (as well as its impacts on labor, such as wages and employment), particularly if the analysis examines a host of different countries with heterogeneous levels of economic development and compositions of exports. To sum, both higher or less backward participation (and forward participation) can lead to or be a result of industrial upgrading, depending on the development level of the country as well as the qualitative composition of its exports and imports. This may mitigate or offset the relationship between higher GVC participation and increased productivity and/or wages. The implications of this finding will be noted later on in this text, as this may be the reason that the few studies that have actually used the two differentiated GVC-related trade indices have shown conflicting results, and that Korea's GVC trade may have different labor market impacts compared to other countries.

1.6.2 Higher growth, development and productivity

One source of concern among policymakers and some academics regarding higher GVC participation is their role in improving productivity. Higher GVC participation's positive effect on productivity first comes from the more general and traditional gains from the expansion of trade and FDI which were discussed earlier in this thesis, as resources shift to more efficient and competitive exporting firms OECD (2013:33). However, because GVC trade is characterized by trade in intermediate goods and services rather than final goods, it particularly amplifies the productivity effects coming from a wider variety of cheaper or better-quality imported intermediates as well as transfers of technology that encourage innovation (*ibid.*). Thus, when examining at the more micro firm-level, companies that engage in global value chain trade have higher productivity levels, which drives industrial upgrading and expansion into more sophisticated bundles of exports (López-González *et al.*, 2015:23; UNCTAD, 2013:165). Firm-level productivity growth and diversification of exports then contributes to higher growth at the country level. Logically, if GVC participation contributes to higher productivity and faster growth, there would also be more employment opportunities created.[38] UNCTAD (2013:148) states that the high integration of some developing countries into cross-border supply chain trade has contributed to the acceleration of their economic growth and movement

[38] There may also be some risks for developing countries, as footloose labor-intensive activities may relocate if wages increase – putting downward pressure on employment. (UNCTAD, 2013:158). Thus, it is crucial to make sure that GVC trade contributes to higher productivity to offset the rising costs of wages, as well as to facilitate spillovers that lead to upgrading to less footloose activities and sustained growth.

towards catch-up and convergence with the income levels of advanced economies. At the same time, however, higher foreign value added embodied in gross exports (more backward GVC participation) means that the direct contribution of exports to gross domestic product (GDP) falls, compared to more traditional types of trade where exported products are produced mostly domestically. A source of concern then is that simply considering exports as a primary policy objective may not contribute as much to economic development as the past, since active participation in global production chains might result in low domestic value added embodied in exports For instance, Timmer *et al.* (2013) found that exports did not generate an equivalent amount domestic income growth in EU countries that rely on imported foreign inputs. Chung (2014) also noted the widening of the gap between Korea's value added exports and gross exports and the fact that each unit of exports contributed less to GDP growth compared to the past. He suggested that Korea's government needs to focus more on generating more domestic value added rather than simply looking at gross exports, perhaps through encouraging more development in the service sector. In relation, the performance of exports in Korean final goods such as Samsung phones or Hyundai automobiles were found to contribute less to Korea's GDP than what policymakers and the public are aware of due to their high composition of foreign value added (low VAX ratios), while intermediate input exports contributed more to Korean GDP growth because they have more domestic value added content.

Nevertheless, recent work on global value chains suggests that the relationship

between higher foreign content in exports due to GVC participation is not necessarily a matter of concern. In fact, even if more GVC-related trade and sourcing of imported inputs implies less domestic value added contained in a given amount of exports (from more backward participation), GVC participation can still lead to higher employment growth (UNCTAD, 2013:156). For instance, developing countries hoping to upgrade from domestic primary goods to more sophisticated manufacturing exports initially start in lower value added activities such as final assembly. At this stage, they are unlikely to immediately be able to produce key inputs for themselves, which necessarily requires growing imports of foreign inputs (Dollar, Khan, and Pei, 2019:142). The usage of competitive foreign intermediates rather than inferior domestic inputs in this stage ensures export competitiveness and therefore more, not less gross as well as value added exports (*ibid.*). Thus, competitive foreign inputs have contributed to the overall success of Korea and Japan's electronic industries even though the domestic value added ratio is relatively low (*ibid.*). In short, the literature suggests that GVC participation encourages productivity and overall growth. The question remains however in identifying the precise channels through which *forward* participation and *backward* participation may provide differing impacts on productivity. Theoretical frameworks on how backward and forward linkages in GVCs affect productivity are still nascent, but López-González (2017) provides some plausible mechanisms. Both direct and indirect *backward* participation in GVCs means that firms are sourcing more imported inputs, either directly from abroad or from another domestic firm that used foreign inputs. As mentioned earlier, higher foreign value added in exports means a broader selection of

sophisticated and competitively priced imports, cutting-edge technology, and inputs that can only be found abroad (López-González, 2017; Ganne and Lundquist, 2019). On the other hand, when firms can directly or indirectly export intermediate goods to third countries (*forward* participation), they can focus on specific activities of production instead of having to vertically integrate all production (López-González, 2017). This could improve productivity by allowing more specialization according to comparative advantage in particular tasks or stages in value chains.

1.6.3 Empirical Analyses on GVCs and Employment

Inequality in labor market outcomes can materialize either in the form of less employment opportunities for certain workers, lower wages, or some combination of both. Even if growth in other industries thanks to productivity effects offsets the loss of jobs in declining sectors, leading to an overall constant or slightly increasing level of employment, compositional changes in the demand for skills may lead to heterogeneous distributional outcomes for workers (OECD 2013). A study by the OECD (2016) showed that between 1995-2011, the number of jobs relying on demand from abroad increased, including many service jobs indirectly embodied in exports. At the same time, the study found that there was a change in composition of the jobs, with less low-skill occupations and more medium or high-skill employment, and more jobs created in intangible high value-added functions such as R&D or marketing rather than fabrication or assembly (*ibid.*). In short, although increased productivity and exports from GVC participation contributed to an increased number of jobs to both export expanding sectors as well as

the industries supplying inputs for the exports, the study suggested that employment was disproportionately generated in higher value-added activities along the value chain, akin to the idea behind the "smile curve." (*ibid.*) Nevertheless, the study emphasized that because many jobs are generated through indirect linkages, the number of occupations relying on trade with foreign markets has reached unprecedented levels, and that therefore protectionist policies would be detrimental for employment. In a similar context, Timmer *et al.* (2013) also found, using education as a proxy for skills, that between 1995-2008 in Europe, high-skilled jobs increased by about 4 million, whereas growth in medium-skilled jobs was stagnant. 6 million low-skilled jobs disappeared in the same period *(ibid.*). The composition of occupations was also seen to shift from manufacturing towards services. Empirical studies on GVC participation and employment thus seem to imply an overall net benefit at the economy level, but a potential skill biased effect favoring high-skilled labor or workers with less educational attainment.

1.6.4 Cross-country Analyses on GVCs and Wages

One of the seminal works differentiating the impacts of backward and forward GVC participation on inequality was conducted by López-González, Kowalski and Achard (2015). Their main finding was that countries which engaged in more offshoring through higher backward GVC participation (foreign value added in exports) tended to have less inequality, and that GVC participation only had a relatively small impact compared to the many other different variables that may affect wage inequality. This finding was

contrary to the general intuition of the public that the expansion of GVC-related trade is a key underlying factor of rising inequality, and was seen to be in line with the theory of Grossman and Rossi-Hansberg (2008) that if the productivity effect dominates the more conventional labor supply effect which occurs when low-skill tasks are offshored, low-skilled workers' wages can increase. An important factor which they considered is the potential composition of low and high-skill offshored activities embodied in the intermediate goods and services that characterize GVC trade, as well as the governance structures of GVCs that would affect which actors specialize in particular tasks as well as how much value added is captured by various actors within the value chain (López-González *et al.*, 2015:11-12). This composition of trade is likely to change depending on how much countries receive or send offshored high or low-skill tasks, and is related to their position in GVCs. López-González *et al.* (2015) linked the concept of backward GVC participation with *offshorability* (sending production activities abroad) and forward participation with *receiving* offshored tasks. Offshoring of low-skilled labor was correlated with less wage inequality while offshoring of high-skilled tasks was associated with greater wage gaps, suggesting a dominant productivity effect over the labor supply and relative price effect in both types of offshoring (López-González *et al.*, 2015:33). The cross-country observation of higher GVC participation correlating with less wage inequality was attributed to the fact that GVC-trade embodies a much higher portion of low-skilled activities as opposed to high-skilled tasks.

In spite of the significance of their empirical findings, as well as the

methodological contribution of differentiating upstream and downstream types of GVC-trade, the composition of exact activities within backward and forward participation could not be clearly identified at a finer level, due to the limits of value added trade statistics (the authors did estimate the proportion of low-skilled and high-skilled workers embodied in the GVC trade). This may be the reason that other more recent studies examining other countries or employing other measures have found conflicting results.

One such example is a recent study by Farole, Hollweg, and Winkler (2018), who found evidence that global supply chain trade may be skill-biased. In particular, more buy-side (backward) global value chain participation or the sourcing of foreign inputs for exports was associated with relatively more returns to skilled workers, which is directly opposite to the findings of López-González*et al.* (2015). In contrast, forward participation showed statistically insignificant results for most countries, although advanced nations were shown to have a significant skill-biased effect (Farole *et al.*, 2018). The authors also note that GVC participation's impact on upgrading and labor markets can occur in opposite directions (Farole *et al.*, 2018:6). As noted earlier, increased usage of foreign intermediates in exports can lead both to more demand for workers due to trade expansion, or it can substitute them due to more automation as the average fixed costs of capital investments fall (*ibid.*). Less domestic value added in exports can lead to greater productivity, but it can also mean substitution of domestic suppliers with overseas firms, which can also either increase or decrease demand for labor (*ibid.*). One difference with the study by López-González *et al.* (2015) was that the

authors were more concerned that offshoring from advanced nations to low-income countries could lead to substitution effects rather than productivity effects, and that therefore backward GVC trade, or sourcing intermediate goods embodied with offshored low-skilled labor from low-income countries could be skill-biased (Farole *et al.*, 2018:7). The paper examined 57 industries for 120 nations, including a large number of developing countries, and used a different data set from López-González *et al.* (2015).

To sum, there are many mechanisms through how GVCs can affect labor markets, in sometimes conflicting directions. Distinguishing backward and forward GVC participation has been shown to be very important by López-González *et al.* (2015) as well as Farole *et al.* (2018), but even when the two types of GVC trade are distinguished, there appear to be conflicting empirical results depending on the data and countries in question. This suggests that there is a high degree of heterogeneity even within both types of supply chain trade in terms of composition of business functions, skills, and upgrading activity which must be considered in the individual context of each country and industries being examined. This is the main reason that the entire following chapter is dedicated to examining the qualitative characteristics of Korea's GVC trade, upgrading, and some empirical literature on offshoring, FDI, and GVCs effects on Korea's labor market.

1.7 Korea in Global Value Chains

1.7.1 Korea's Prominent Role in GVC Trade

In order to more accurately predict the impact of GVC participation on labor markets, country-specific characteristics such as the level of economic development, the unique mix of activities embodied in GVC trade, and their relationship with industrial upgrading must be kept in mind. With this in mind, this section examines Korea's global role in trade, as well as the links between its development path and GVC participation. The goal is to analyze the qualitative characteristics of Korea's intermediate inputs trade in backward and forward participation, as they may have affected the demand for workers with different skills through channels such as industrial upgrading and technology transfer embodied in trade. Selected empirical works on the impact of trade (particularly supply-chain trade) on Korea's labor market are also consulted, although Korean work specifically using the most recent GVC indicators based on value added trade are scarce. The qualitative analysis in this section of the paper on Korea's position in the international division of labor and fragmentation of production is presented in order to support the construction of the hypotheses to be tested in the following quantitative chapters which comprise the core of this thesis. Furthermore, the importance of Korea as a major trade partner and regional manufacturing hub, as highlighted in this section, should interest diverse fields of researchers aiming to better understand and examine the linkages of the international economy.

Korea's share in world trade is disproportionately larger than the size of its economy, in comparison with other economies of comparable mass and income. To illustrate, while it was recently ranked as the 11th largest economy according to size of its GDP[39], it was the world's 5th largest exporter in gross merchandise trade in 2015 and 2016, similar to France and more than economies such as Italy, Canada, the U.K., Spain, or Australia.[40] In spite of Korea being a major player in the global economy, it has received relatively less attention compared to its East Asian neighbors, China and Japan, perhaps due to the sheer relative size of their populations and economies (China and Japan's populations are roughly 27 times and 2.5 times larger than Korea[41]), which "makes it look like a 'shrimp among whales' by comparison (Lim 2011: 179-180)." Nevertheless, a quick examination of Korea shows that its role in GVC-related trade is even more significant than its already sizable portion in conventional trade.

Along with Japan and China, Korea is part of a "tripartite regional production network" (Das and Han, 2013) linked through triangular trade, which is a focal point among the three main interconnected production centers in GVCs, with the other two being European (Germany in the core) and North American (U.S.-centered) (Dollar 2017:6-7). These three production hubs are illustrated from both the supply and demand side of the ICT industry in the following figures constructed by Meng *et al.* (2018) and

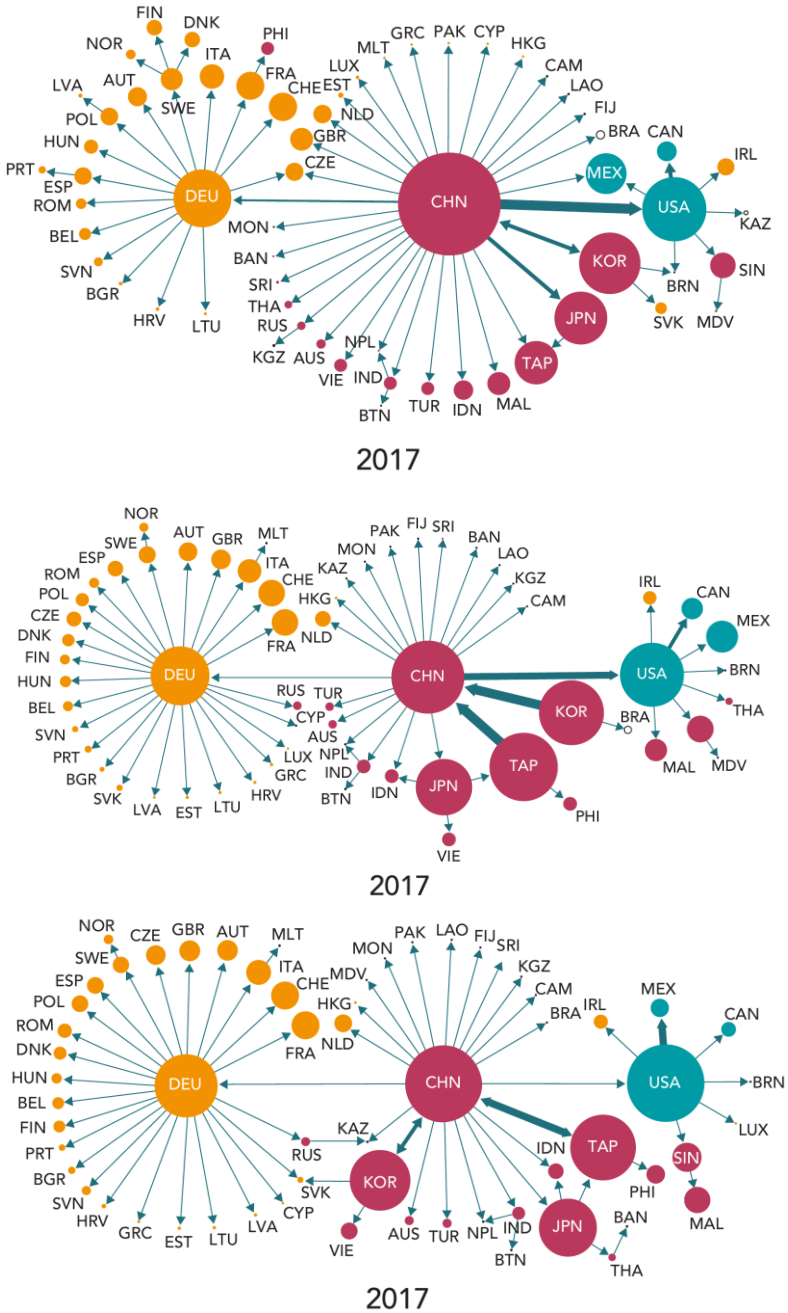
[39] World Bank (2019a), World Development Indicators (WDI) 2017
[40] World Bank (2019b), World Integrated Trade Solution (WITS), (trade data derived from UNCOMTRADE)
[41] South Korea's population is approximately 50 million, slightly larger than Spain and similar but somewhat smaller than the U.K., France, and Italy (WDI, 2018).

presented in Li *et al.* (2019), with Korea denoted as "KOR." The diagrams show that Korea is a major supply and demand link for traditional "Ricardian" trade in final consumption goods and services, as well as in GVC-trade in intermediate inputs used for further production.[42] The size of Korea's circle shows that it has a large share of value added exports analogous to Germany (DEU), Japan (JPN), and Taiwan (TAP), while the arrows show links with trading partners

[42] The diagrams decompose GVC trade further into simple GVCs that cross borders once, as well as complex GVCs characterized by goods that repeatedly cross borders multiple times (Li *et al.* 2019).

FIGURE 2.19 SUPPLY HUBS OF VALUE-ADDED TRADE, ICT SECTOR

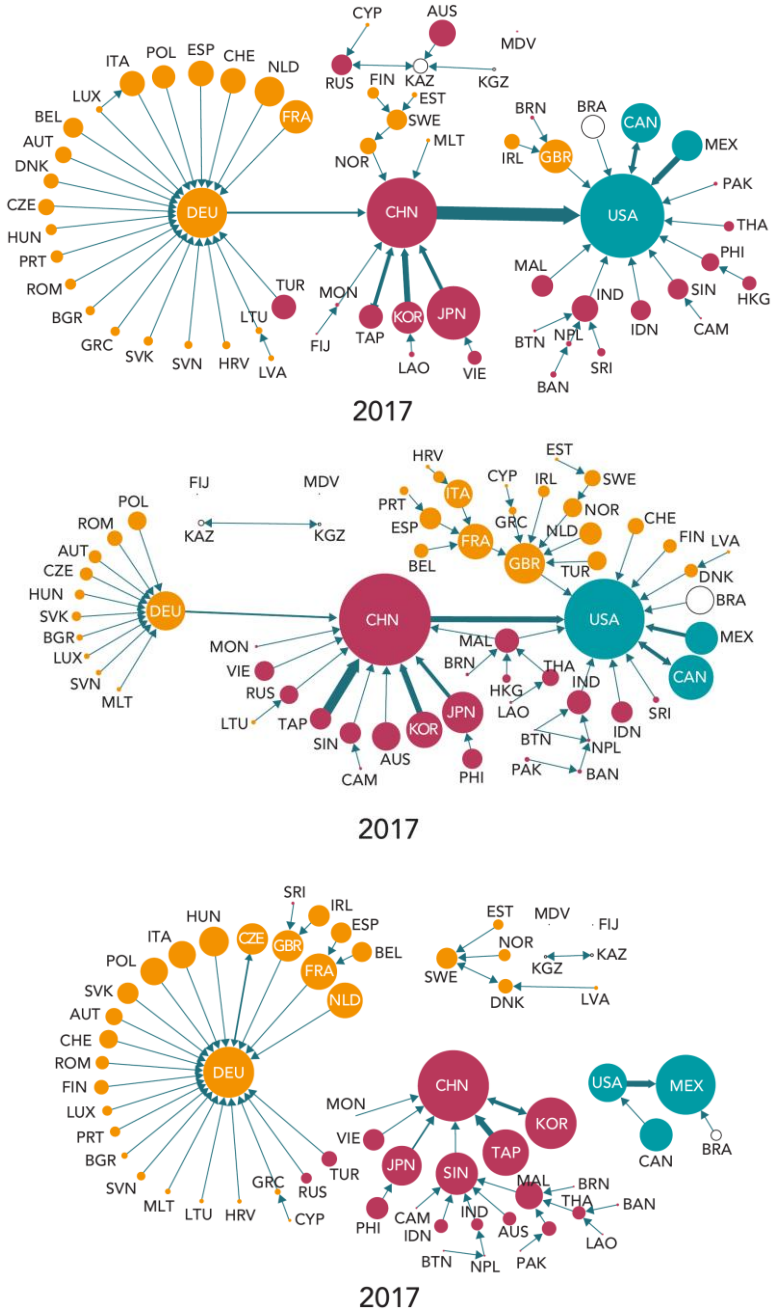
Traditional, Simple, and Complex GVC Trade Networks (order: top to bottom)



Source: Li *et al.* (2019:29) & Meng *et al.* (2018) based on UIBE GVC indices & ADB ICIO tables

FIGURE 2.20 DEMAND HUBS OF VALUE-ADDED TRADE, ICT SECTOR

Traditional, Simple, and Complex GVC Trade Networks (order: top to bottom)

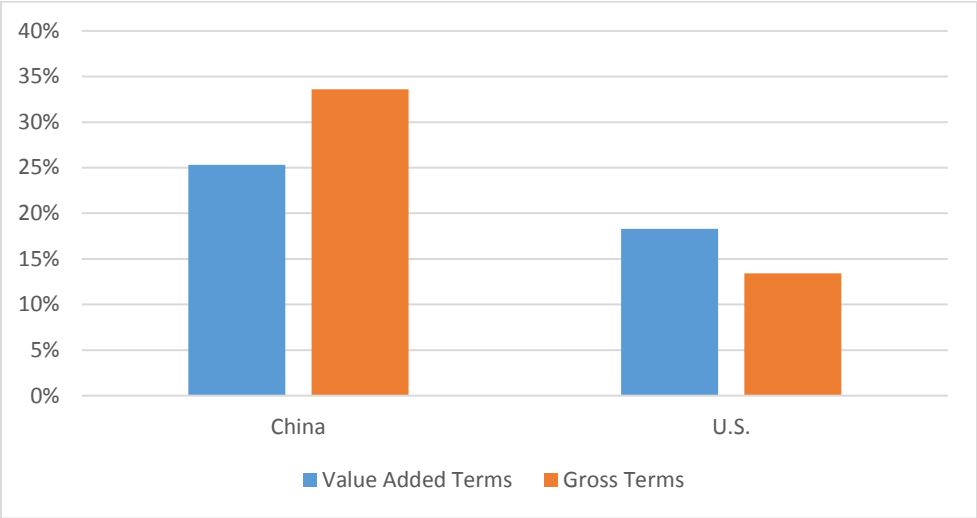


Source: Li *et al.* (2019:29) & Meng *et al.* (2018) based on UIBE GVC indices & ADB ICIO tables

Korea's relative importance in the global economy appears to be even higher when examining its role through the lens of GVC-related trade rather than conventional trade statistics. For example, although Korea was China's 3rd largest export destination in terms of gross exports in 2015, behind the U.S. and Japan, it was China's most important GVC-trade partner. Specifically, Korea was China's top source of foreign intermediate inputs (11.4%) used for China's exports to the world (i.e., China's largest backward participation partner), which was more than the U.S. (11.2%) or Japan (9.3%), the world's largest and third-largest economies.[43][44] China's largest forward participation partner was also Korea (11%), not the U.S. (9.2%) or Mexico (7.7%). It was noted earlier that when measuring trade balances in value added terms instead of conventional gross terms, China's bilateral trade surplus with the U.S. falls, Korea's trade surplus with the U.S. increases, and Korea's surplus with China falls - the reason being that China is an export processing platform for Korea's intermediate input exports. The following figure confirms this, with the blue (left) value added column is lower than the orange (right) gross trade column for Korea's export share with China, while it is higher for the United States. Korea's indirect exports to the U.S. also go through other export processing platforms such as Vietnam and Mexico in the form of forward GVC participation. The arrows in the previous figures by Meng *et al.* (2018) also highlight how Korea heavily engages in forward GVC trade to China. A more detailed analysis of the composition of forward and backward participation is provided in the following section.

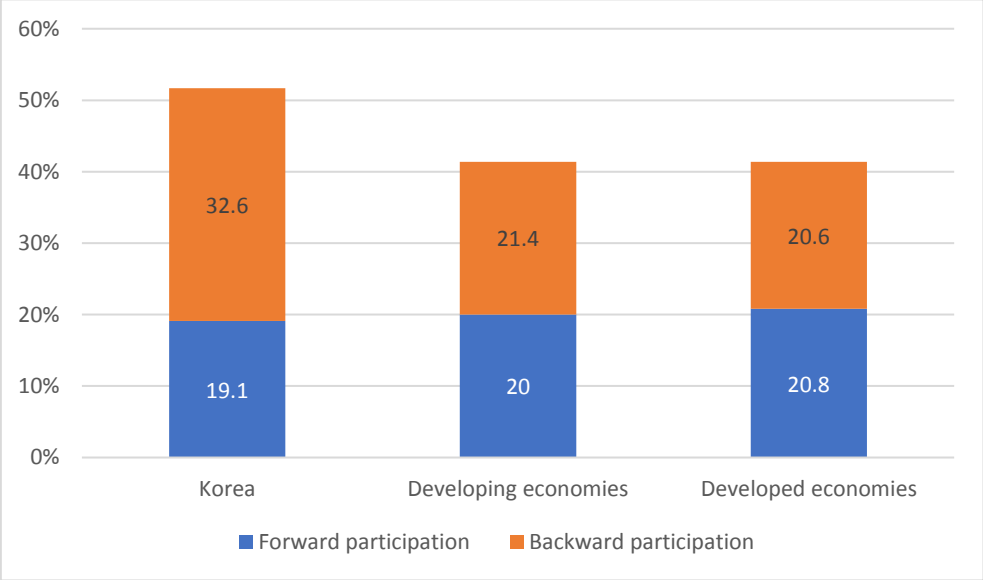
43 WTO (2019) Statistical Profiles (Derived from OECD TiVA Database covering 2005-2015)
44 https://www.wto.org/english/res_e/statis_e/miwi_e/CN_e.pdf

FIGURE 2.21 KOREA'S EXPORT SHARE WITH TOP TRADE PARTNERS, 2015



Source: Author's calculation based on OECD TiVA and WTO Statistical Profiles (2019)

FIGURE 2.22 KOREA'S TOTAL GVC PARTICIPATION COMPARED WITH DEVELOPING AND DEVELOPED COUNTRY AVERAGES, 2015

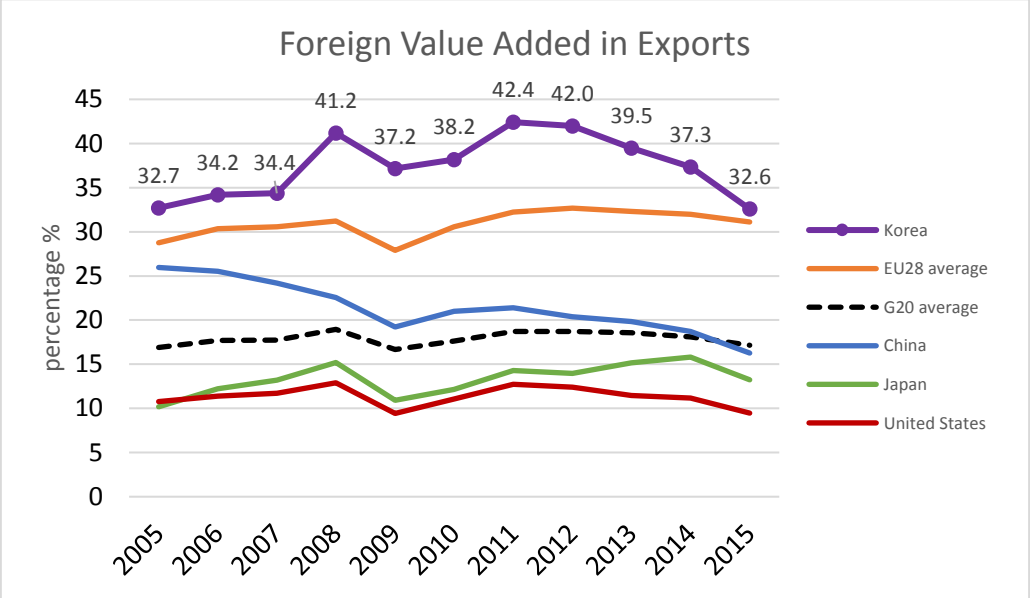


Source: Author's calculation based on OECD TiVA and WTO Statistical Profiles (2019)
Notes: Sum of top (backward) and bottom (forward) column is total participation

In 2015, Korea's total (51.7%) and backward participation (32.6%) (see **Figure 2.2**2 on the previous page) were considerably higher than the average of both developed and developing countries, while its forward participation was similar to the average of other countries, about 19.1%.[4546] Korea's backward GVC participation (figure 5), measured as foreign value-added embodied in gross exports, has fallen since its peak in 2011, from 42.4% to 32.6%. However, this share is still higher than the OECD average and among the top of G20 countries (OECD 2018)[47]. It should be noted that part of the changes in backward participation are due to changes in the prices of raw materials and energy inputs such as crude oil (*ibid.*). Much of Korea's backward participation consists of either raw materials and energy inputs from countries such as Saudi Arabia, as well as sophisticated inputs from countries such as Japan, the U.S., or Germany. In particular, Japan's 3rd largest gross export destination and 2nd largest forward participation export partner in 2015 was Korea. [48] Bearing in mind the relative size and development of Korea, it uses a significantly large share of foreign inputs in its exports in comparison with other countries (Baldwin 2012:16).

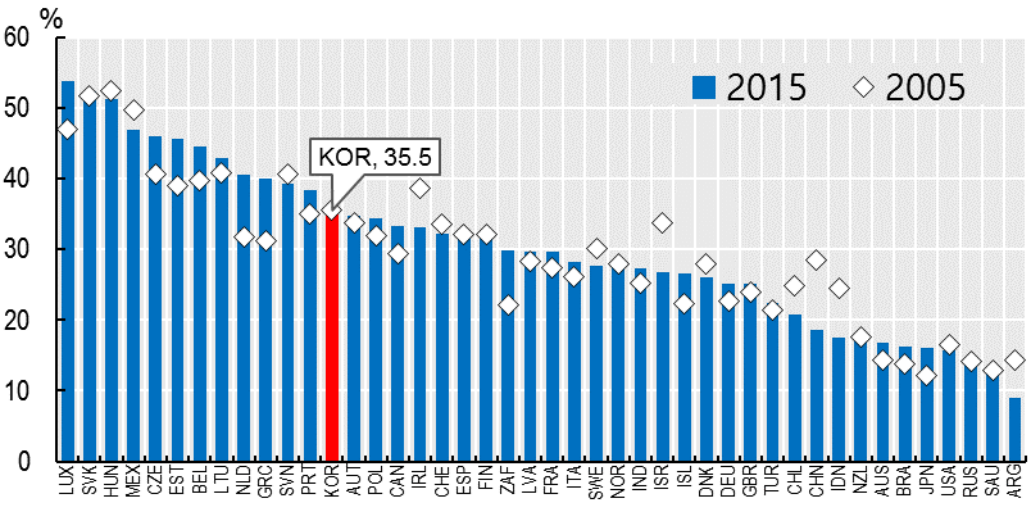
45 https://www.wto.org/english/news_e/news19_e/miwi_09may19_e.htm
46 https://www.wto.org/english/res_e/statis_e/miwi_e/KR_e.pdf
47 http://www.oecd.org/industry/ind/TIVA-2018-Korea.pdf
48 https://www.wto.org/english/res_e/statis_e/miwi_e/JP_e.pdf

FIGURE 2.23 KOREA'S BACKWARD GVC PARTICIPATION TREND, INTERNATIONAL COMPARISON, 2005-2015



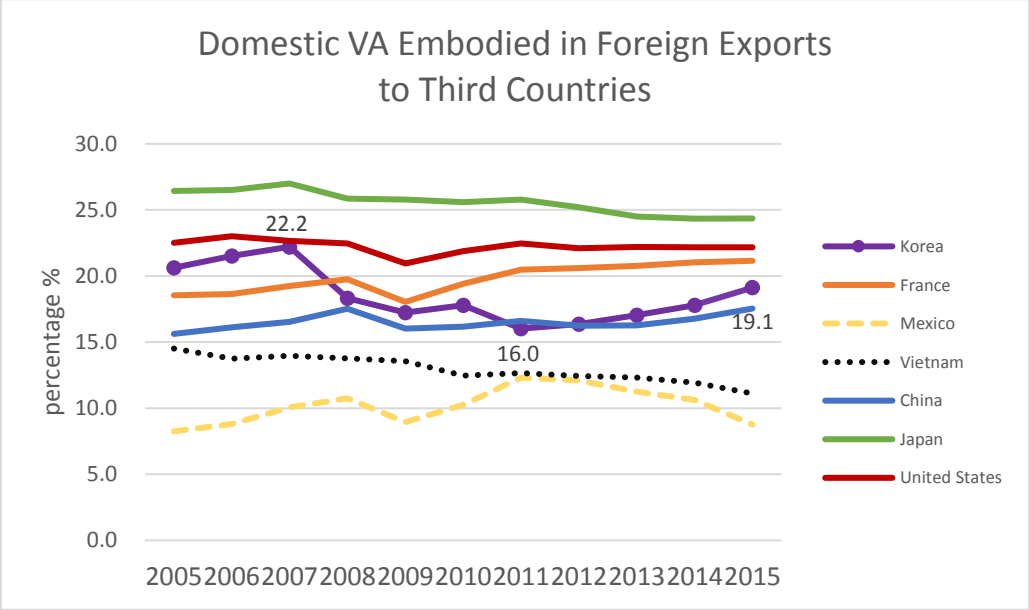
Source: Author's calculation using "Foreign value added share of gross exports, 2005-2015" in the OECD TiVA database, December 2018 version

FIGURE 2.24 BACKWARD PARTICIPATION OF MANUFACTURED EXPORTS, 2005 AND 2015



Source: OECD, Trade in Value Added (TiVA) database, December 2018 version
Notes: Backward participation defined as foreign value added embodied in exports

FIGURE 2.25 KOREA'S FORWARD GVC PARTICIPATION TREND, INTERNATIONAL COMPARISON, 2005-2015

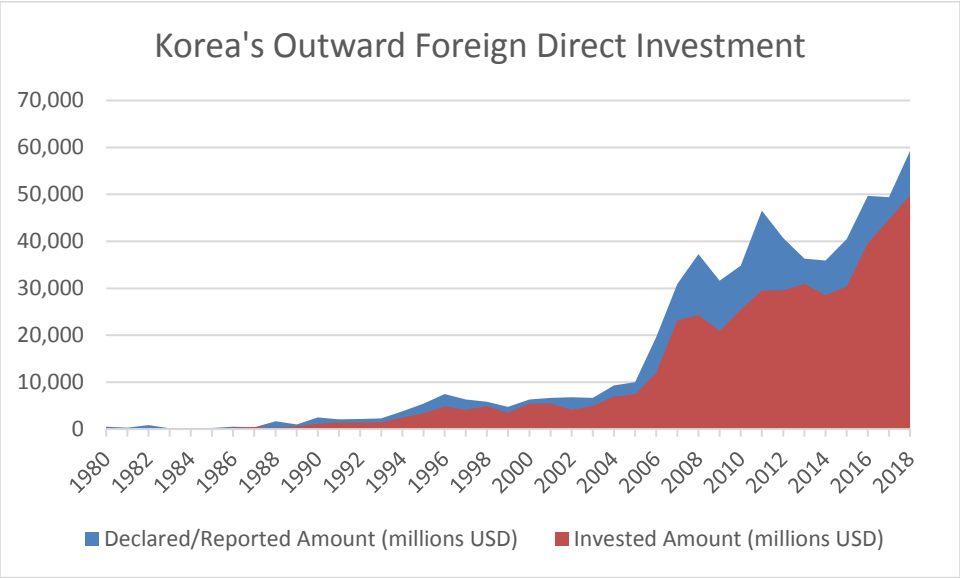


Source: Author's adaptation of OECD TiVA database, December 2018 version (Domestic VA embodied in foreign exports to third countries, as % of total gross exports of the source country

In contrast, much of Korea's forward participation exports of inputs to third countries went through assembly hubs such as China (37.1%), Vietnam (6.6%) and Mexico (5.0%) in 2015.[49][50] This contrasts with Korea's top export destinations (China, the U.S., and Japan[51]) in terms of traditional gross exports. In relation to the importance of processing trade, Vietnam's 2nd largest source of foreign imported inputs used for exports was Korea (11.4%), showing a larger presence of bilateral GVC trade compared even to Japan (7.4%).[52]

49 *Ibid.*
50 Or China 41.1%, the U.S. 5.9%, and Taiwan 5.2% in 2011 (WTO 2016 Version Profiles)
51 More recently, Vietnam has overtaken Japan
52 https://www.wto.org/english/res_e/statis_e/miwi_e/VN_e.pdf

FIGURE 2.26 KOREA'S OUTWARD FDI, 1980-2018



Source: Foreign Direct Investment Statistics, The Export-Import Bank of Korea[53]

The importance of Korea's forward participation in Asian supply chains is closely intertwined with the surge of outward foreign direct investment (FDI) into China and Southeast Asia by mostly Korean conglomerates known as *chaebols*. Reasons for this trend include active participation in preferential trade agreements as well as relatively close geographical proximity, but also the upgrading of Korea's MNCs into higher value added business functions and offshoring less sophisticated activities to low wage economies. Korean multinational conglomerates known as chaebols have been outsourcing many activities to suppliers in China and Southeast Asia (ASEAN) as well as directly owning new factories in these countries through subsidiaries.

53 Korea Export Import Bank (2019), Foreign Direct Investment Statistics

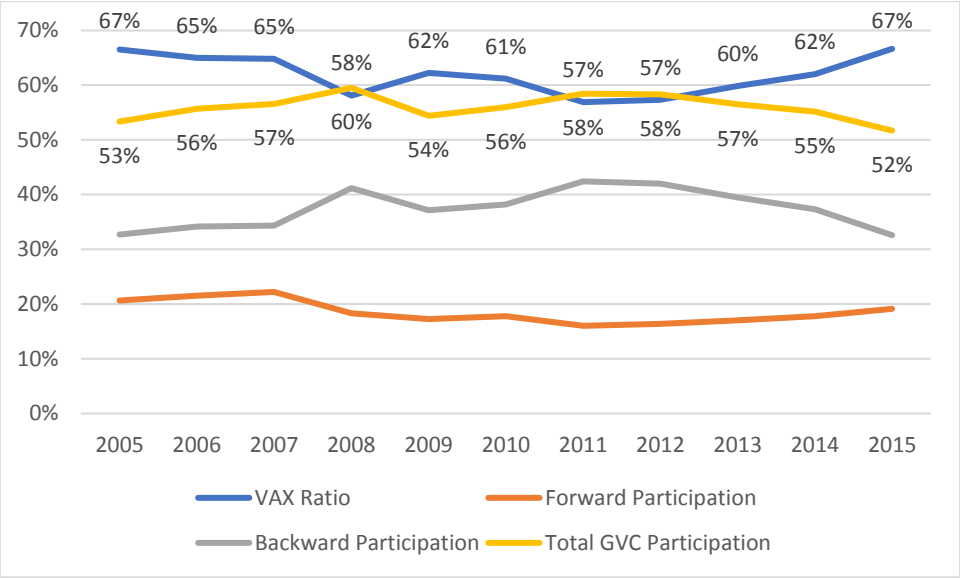
FIGURE 2.27 TOP 20 KOREAN MNCS AND LOCATIONS OF SUBSIDIARIES IN ASEAN, 2015

Rank	Company	Industry	Foreign assets	Presence in ASEAN
1	Samsung Electronics	Conglomerate	18,449	Indonesia, Malaysia, Philippines, Singapore, Thailand, Viet Nam
2	POSCO	Conglomerate	8,160	Cambodia, Indonesia, Malaysia, Myanmar, Philippines, Singapore, Thailand, Viet Nam
3	Hyundai Motor Company	Conglomerate	6,786	Malaysia, Singapore, Viet Nam
4	Korea Gas Corporation	Gas utility	5,419	..
5	LG Chem	Conglomerate	4,239	Singapore
6	LG Electronics	Conglomerate	3,456	Indonesia, Malaysia, Philippines, Singapore, Thailand, Viet Nam
7	SK Hynix	Semiconductors and related devices	3,165	Singapore
8	Korea Electric Power Corporation	Electricity	2,670	Indonesia, Lao People's Democratic Republic, Malaysia, Philippines, Singapore, Viet Nam
9	Lotte Chemical Corporation	Petrochemicals	2,045	Malaysia
10	Lotte Shopping	Conglomerate	2,017	Indonesia, Philippines, Singapore, Viet Nam
11	Samsung Display	Display panels	1,955	Singapore, Viet Nam
12	Kia Motors Corporation	Motor vehicles	1,617	..
13	Samsung C&T Corporation	Conglomerate	1,591	Indonesia, Malaysia, Philippines, Singapore, Thailand, Viet Nam
14	LG Display	Display panels	1,565	Singapore
15	Hyundai Mobis	Automotive parts	1,162	..
16	SK Telecom	Telecommunications	1,155	Singapore
17	Hyosung Corporation	Conglomerate	896	Indonesia, Singapore, Viet Nam
18	Samsung SDI	Display panels and batteries	874	Malaysia, Thailand, Viet Nam
19	Hyundai Heavy Industries	Conglomerate	873	Indonesia, Malaysia, Philippines, Singapore, Viet Nam
20	SK Innovation	Conglomerate	812	Indonesia, Malaysia, Singapore

Sources: ASEAN & UNCTAD (2016:29) based on Moon & Yin (2015), Orbis database and company annual reports, foreign asset data 2013 statistics

The offshoring activity of Korean MNCs is thus one of the main reasons behind the surge of both intra-firm trade and intermediate inputs trade in the region, and some qualitative characteristics of this trade will be discussed in the following section in relation to Korea's development and industrial upgrading.

FIGURE 2.28 VALUE ADDED EXPORT RATIO VS. GVC PARTICIPATION, KOREA 2005-2015



Source: Author's calculation using OECD TiVA data, December 2018 version

As expected, the aggregate value added export ratio of Korea is highly correlated with total GVC participation, showing an approximately inverse relationship. The VAX ratio fell from about 0.665 in 2005 to 0.569 in 2011 at the peak of Korea's GVC integration, before recently rising to 0.667 in 2015. This trend is similar to how GVCs have become less intensive in other countries following "the great collapse in value added trade" after 2008.[54]

54 See Nagengast and Stehrer (2016), for a discussion

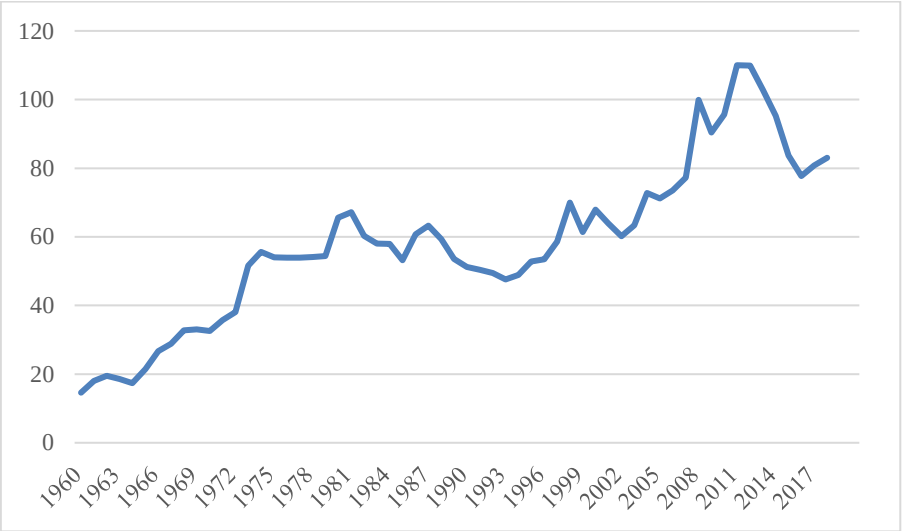
1.7.2 Factors underlying Korea's GVC participation

Korea's economic structure is the main factor behind its heavy integration with GVCs. López-González *et al.* (2015:24) and the OECD (2015a) noted that GVC participation can be determined both through structural factors which countries are more or less endowed with in the short run (level of development, geographical location, population), as well as through policy factors, which include the role of the government in promoting trade and investment. Likewise, the organization of Korea's economic architecture and heavy participation in supply chain trade is partly due to its inherent factor endowments (lacking natural resources, relatively small domestic market size, proximity with China, Japan, and Southeast Asia) but also due its development path and industrial composition of exports.

The origins of Korea's disproportionately high weight in global supply chain trade can be attributed to the characteristics of its key export industries, as well as in the developmental history of Korea. Korea is now well known for its high-speed growth and continuous industrial upgrading as it transformed from one of the world's poorest agrarian, resource-lacking nations into an advanced manufacturing hub (the Miracle on the Han River), largely through exports and a focus on improving educational attainment. Its GDP per capita adjusted to purchasing power parity (PPP) in current international dollars was about $40,479 in 2018.[55]

[55] World Integrated Trade Solution (WITS) (2019) based on World Bank GDP data (WDI)

FIGURE 2.29 KOREA'S GROSS TRADE SHARE (% OF GDP)



Source: World Development Indicators, 2019
Notes: Sum of exports and imports of goods and services as a share of GDP, trade data derived from World Bank and OECD National Accounts Data

The high reliance of Korea's economy on trade is shown in the following figure, as well as in Figure 2 in the introduction of this thesis – as of 2015, at least 25.2% of Korean employment seems to be linked to demand from foreign markets, one of the highest shares among major economies. The top export industries of Korea in 2015 were ICT electronics (such as computers, semiconductors, phones), motor vehicles and parts, ships, and petroleum/chemical products.[5657] Meanwhile, being a natural resource-poor country, Korea imports raw materials and energy (such as crude oil)[58] as well as sophisticated

[56] WTO (2019) Statistical Profile of Korea (2005-2015) / Data derived from OECD TiVA
[57] Observatory of Economic Complexity (2019), 2015 data - Raw trade data on goods derived from UN COMTRADE, data on services from IMF-WB Development Indicators
[57] Saudi Arabia was the third largest input provider in Korea's backward participation trade in 2011 (9.5%), (WTO 2016 Version Profiles)

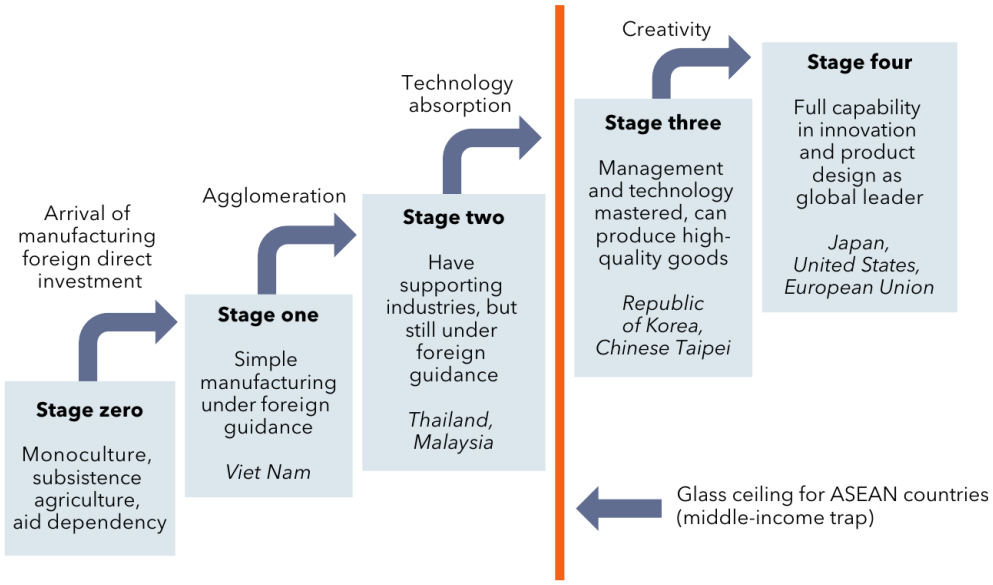
inputs from advanced nations such as Japan. Korean conglomerates, known as *chaebols*, have led Korea's state-supported export-oriented growth and participated in GVCs since the early 1960s, and the Heavy Chemical Industry (HCI) Drive of the 1970s led to an increasing role of large MNCs in Korea's economy (Amsden, 1989; Castley, 1997; Cho *et al.* 2017:45-48; Chung, 2016:46; Johnson, 1982, 1987, 1999; Kohli 1994, 2004; Woo-Cumings, 1991, 1998, 1999). Although democratization and economic liberalization in the late 1980s led to the fall of the importance of the developmental state's role (Lim 2011 , Lee *et al.* 2014 , Yeung 2014), chaebols such as Samsung, LG, Hyundai, SK, and POSCO continue to contribute a significant role in Korea's exports and GDP and have turned into well-known brands across the globe (Cho *et al.*, 2017).

1.7.3 Korea's Export-Led Growth and Industrial Upgrading Path

Korea was among the early NICs that started out as export platforms based on cheap but diligent, disciplined labor, and later moved on to upgrade into more upstream industries, often through buying technology and capital goods from Japan's declining "sunset" industries (Castley, 1997). The government played an important role in moving Korea up the industrial ladder from textiles (*ibid.*, 92-94) to strategic heavy industries in chemicals and steel (against the "opposition of economists from the World Bank and IMF"), which became important backward linkages for Korea's future shipbuilding and automobile industries, as well as high-tech industries further in the future. GVCs during these decades were relatively nascent; according to Cho *et al.* (2017:15-16), foreign outsourcing of simple assembly in parts and components began in the mid-1960s, but

accelerated to a more global scale in the 1970s and 80s largely due to the activities of global retail and consumer brand MNCs such as the GAP (Gereffi, 1994). Prior to the 1990s, late industrializers such as Germany, Japan, and Korea had to build relatively full sets of domestic backward linkages and supply chains within their national boundaries, with the goal of moving from primary sectors such as agriculture, and then sequentially to light, heavy, high-tech manufacturing and finally services (Cho *et al.*, 2017:27-28). In contrast, developing countries in the contemporary world can now specialize in specific

FIGURE 2.30 OHNO'S STAGES OF CATCH-UP INDUSTRIALIZATION



Sources: Engel & Taglioni (2017:122) based on Ohno (2009)

business functions (i.e. assembly) instead of having to develop whole sets of industries and vertical linkages, and upgrading is more focused on moving to new activities regardless of the type of industry - arguably a new paradigm of economic development (Baldwin, 2013:39; Cho *et al.*; 2017:27-28; Gereffi, 2014; Taglioni and Winkler, 2016).

However, it was only in the 1990s and 2000s when GVCs achieved the degree of expansion akin to today's world in a much wider spectrum of goods and services. Thus, Korea's development path has a *mix* of characteristics similar to late industrializers such as Germany and Japan, as well as more recent developing countries whose growth is based on contemporary global value chains.

FIGURE 2.31: CHANGES IN KOREA'S TOP 10 EXPORTS

	1960	1970	1980	1990	2000	2010	2018
1	Iron ore	Textiles	Textiles	Electronics	Semi-conductors	Semi-conductors	Semi-conductors
2	Tungsten	Plywood	Electronics	Textiles	Computers	Ships	Petroleum Products
3	Raw silk	Wigs	Iron & steel products	Footwear	Automobiles	Phones	Automobiles
4	Anthracite	Iron ore	Footwear	Iron and steel	Petrochemical Products	Petroleum Products	Flat panel displays
5	Cuttlefish	Electronics	Ships	Ships	Ships	Automobiles	Auto parts and components
6	Live fish	Fruits and vegetables	Synthetic Fibers	Automobiles	Wireless Phones & Devices	Flat panel displays	Synthetic resins
7	Graphite	Footwear	Metal products	Chemicals	Iron and steel products	Auto parts and components	Ships
8	Plywood	Tobacco	Plywood	General machinery	Textile products	Plastic products	Iron and steel products
9	Rice	Iron and steel products	Fish	Plastic products	Textile Fabrics	Organic & inorganic compounds	Wireless Phones & Devices
10	Bristles	Metal products	Electrical goods	Containers	Electronic Appliances	Electronic Appliances	Plastic products

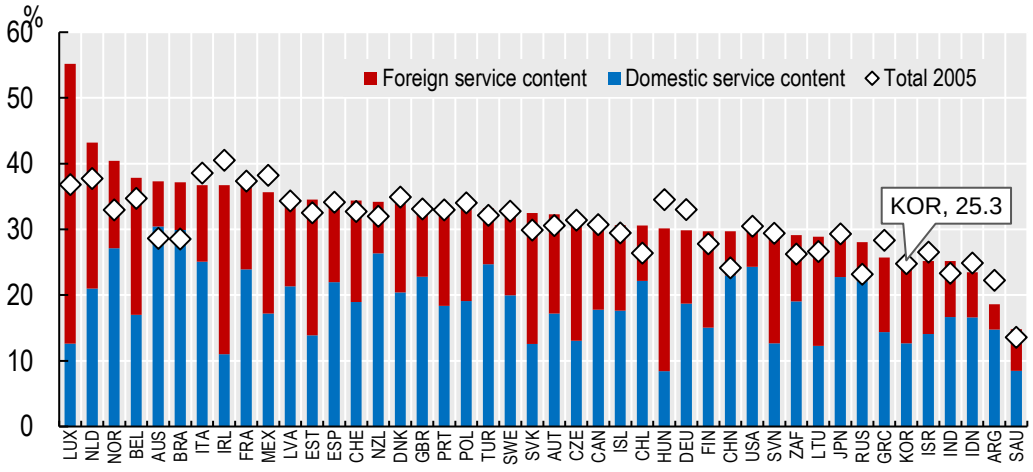
Sources: K-STAT Database (KITA, 2019), Author's translations based on Wonhyuk Lim (2011)

The general understanding among researchers has been that Korea's location in the flying geese pattern is just after Japan and before China and the Southeast Asian economies. The change in Korea's export composition at the *industry* level seems clear when looking at **Figure 2.31**. The top exports have changed drastically from primary agricultural, fishery, and raw material exports in the 1960s, light manufacturing (textiles, wigs) in the 70s, heavy industries in the 80s (iron and steel products, ships), to electronics, automobiles and chemicals in the 90s. An interesting feature since the 2000s is that aside

from the importance of high-tech *final* products such as computers, automobiles, ships, and wireless devices, much of the top 10 exports now include important *intermediate* inputs such as semiconductors, refined petroleum products, synthetic resins, plastics, as well as auto parts and components, which are used more upstream in global value chains. Thus, a quick scan of the compositional change in Korea's gross exports seems to simply imply that Korea followed the traditional type of industrial upgrading. However, although Korea may have built more complete sets of domestic backward linkages within supply chains compared to the developing nations of today, it has nevertheless from the early beginning sourced key inputs from abroad, leading to high import content in its exports. Usually, there was a simultaneous progression in upgrading at the overall industry or product level as well as business function level. Whenever the government steered Korea into the next phase of industrialization, the new wave of final consumption good exports (such as ships or automobiles) required the purchasing of many advanced economies' inputs such as engines, due to the lack of domestic technology and R&D capabilities, until Korean firms sufficiently developed business functions capable of upgrading domestic backward linkages and partially substituting foreign value added. At the same time, the composition of key exports has increasingly embodied highly energy intensive industries, which has meant a continued reliance on foreign value added from raw material exporters. Thus, the compressed growth of Korea's economy based on importing foreign raw materials and sophisticated inputs for exports has been a defining feature since its economic take-off. However, many of the "high-tech" industries that Korea successfully shifted to in the 1980s and 90s, such as electronics,

automobiles, and refined chemicals also happen to be increasingly fragmented at the global level, with more and more export opportunities in global value chains through forward participation to new developing countries in the next stages of the flying geese model. Thus, Korea's composition of exports since the 1990s and particularly 2000s increasingly featured not just industrial upgrading at the traditional product level, but more in higher value added business functions such as R&D and brand marketing, which may imply that there has been a growth of high-skilled tasks embodied within exports, especially within the GVC-trade related forward linkages.

FIGURE 2.32. SERVICES VALUE ADDED EMBODIED IN MANUFACTURING EXPORTS, BY DOMESTIC AND FOREIGN ORIGIN, 2015 (% OF TOTAL MANUFACTURING EXPORTS)



Source: OECD, Trade in Value Added (TiVA) database, December 2018

The relatively low services value added in manufacturing exports of Korea compared to other OECD countries may make some observers question this presumption. As shown in the following graph, Korea's proportion of services value added in

manufacturing exports was about 25.28% (12.67% domestic services and 12.61% foreign services content) in 2015.[59] However, an important reason behind this is that many firms in Korea (in particular, the chaebol conglomerates) that are in manufacturing create services for themselves in-house, and this is calculated as manufacturing value added rather than services value added. The OECD (2018) states that the proportion of services embodied in *overall* exports of Korea was 34.5% in 2015, still lower than the OECD average of 54%. Nevertheless, this is still a substantially high amount when considering the heavy share of manufacturing firms in Korea's economy leading to downward bias in estimates, highlighting that services play an important role for Korea's trade.[60]

1.7.4 Shifting to Higher Value Added Activities and Offshoring Assembly

A qualitative description of the current state of Korea's key export industries demonstrates that the composition of Korea's exports has indeed shifted into higher value added and technology-intensive business functions. The electronic machinery and ICT industries are the most fragmented sectors in GVCs, with key intermediate inputs such as semiconductors and displays as well as final products such as smartphones and computers which use those intermediate inputs *all* having respective, highly fragmented cross-border supply chains. Raw materials such as rare earths and metals, silicon, plastic,

[59] Similarly, 24.81% in 2005

[60] OECD (2018d) "Trade in Value Added: KOREA," Country Note December 2018 version

and refined chemicals are fabricated in the next stage of the value chain into electronic components, with some of the most critical and expensive being *integrated circuits* or *semiconductors* used to store memory, as well as *liquid crystal displays* (LCD) *and organic light emitting diodes* (OLED) such as active-matrix OLED (AMOLED) (Cho *et al.* 2017:80-85). These expensive inputs now comprise the *largest portion* of Korea's exports, with semiconductor memory chips mostly exported by Samsung and SK Hynix.[61] According to an analysis by the Korea International Trade Association (KITA), Korean firms dominated 63.7% of the world semiconductor market in 2018 (dynamic random-access memory DRAM 72.3%, NAND 49.5%)[62]. Production of semiconductors is heavily integrated in GVCs, with Japan supplying important inputs, Korea producing semiconductor memory chips, and China assembling final products as well as providing simpler inputs of lower quality and cost. Korean MNCs such as Samsung and LG Display also dominate 97% of the global OLED screen market used for computers, smartphones, and TVs, while still leading LCDs with a market share of 37%, in comparison with China (27%), Taiwan (24%) and Japan (10%) (Cho *et al.* 2017:104).[63]

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[61] Harding and White (2019) "Japan hits South Korea with semiconductor sanctions: Step marks escalation of row over compensation for forced wartime labour" 1 July, *Financial Times*

[62] Kim (2019) "Playing competitors against each other? Why China can't just smile contentedly at the semiconductor dispute between Korea and Japan," *The Korea Times*, 18 July (*in Korean*) "어부지리? 한일 반도체 갈등에 마냥 웃지 못하는 중국" 2019.07.18 16:24, 김광수 기자

63 According to Lee *et al.* (2014:110-11), the world's top two LCD panel producers, Samsung and LG comprised 53.8% (27.6%, 26.2% respectively) of world market share in 2011, compared to Taiwanese firm AUO (15.7%) and CMI (now Innolux, 15.3%), as well as Sharp of Japan (7.4%)

Samsung's memory chips and OLED screens are used in many different value chains, such as U.S. iPhones, Chinese Huawei smartphones as well as Sony laptop PCs.[64] Moreover, their importance as upstream inputs are increasing, as more and more value chains that were previously less related to electronics have begun to integrate IT technology in order to provide higher value to customers. German auto manufacturer Audi, for instance, incorporates Samsung's processors into its car infotainment systems.[65]

The competitiveness of these firms partly stems from their role in GVCs – R&D, brand marketing, and sales are mostly concentrated in headquarters in Korea as well as some locations in other advanced economies, where an abundance of highly-educated workers and sophisticated consumers allow those stages of production to be most efficiently executed. Leading the world market for semiconductors and flat panel displays is by necessity dependent on R&D activities, while to recoup the costs of these heavy investments, ensuring sharp economies of scale by producing in large volumes with minimum costs are important. As a result, Korean MNCs have increasingly offshored a large amount of assembly activities to China and Vietnam, which participate in the Information Technology Agreement (ITA) of the WTO that completely removes tariffs on ICT products, allowing the firms to exploit low unit labor costs without

[64] JTBC (2019) "Sony and Apple use Korean Semiconductors: Second-hand Indirect Damage from Abe's Export Restrictions," *JTBC*, 3 July (*in Korean*) "한국산 반도체 쓰는 소니·애플...아베 폭주에 '2차 피해'"

[65] Samsung (2019) "Samsung's Exynos Auto 8890 Powers In-Vehicle Infotainment System in the New Audi A4 and Upcoming Models" 30 May, 2019

worrying about duties (Joo, 2015). Korean electronics MNCs are thus heavily integrated into GVCs with China and Vietnam through both arms-length contracts with suppliers abroad and through vertical integration in FDI. For instance, in 2008, Samsung's factories in China (Tianjin, Shenzhen and Huizhou) provided 54% of Samsung's mobile phone output, more than Korea's then production of 41% (Cho *et al.* 2017:118-123). In the following decade, Korean firms shifted FDI into Vietnam, contributing to an exponential growth in Korea's trade with Vietnam, particularly in parts and components (Joo, 2015). Samsung alone hires 150,000 employees and contributes to 20% of Vietnam's gross exports and is currently Vietnam's largest foreign investor (Joo, 2015). Thanks to increased integration into ICT GVCs, Vietnam's electronics exports in 2015 were almost 50 times larger than in 2002, over a period of just 13 years (Cho *et al.* 2017:118). In a similar vein, Das and Han (2013:290-297) found that after Hyundai Motors established a joint venture in Beijing, China, trade in automobile parts between Korea and China increased fourfold between 2002-2012. Aside from the Hyundai-KIA Motor Company, better known among household consumers and one of the world's largest car manufacturers, Hyundai Heavy Industries (HHI) is the world's top producer in shipbuilding, receiving about 10% of all global orders (Cho *et al.* 2017:187-259). In fact, Korea is the world's leading ship exporter, specializing in LNG and oil tankers as well as containerships, and controlling 34.4% of world shipbuilding production, a large portion of the total of 91% controlled by the three countries of China, Korea, and Japan in 2015 (Cho *et al.* 2017: 189-191, 259). As mentioned earlier, although this industry is less vertically specialized compared to electronics, many key components such as

engines are sourced from other countries, and access to cheap steel and foreign technology spillovers have been crucial to maintaining or improving competitiveness.

In short, although exports and regional production sharing arrangements have assisted Korea's development since the 1960s, its development strategy and subsequent composition of imports and exports were initially more of a hybrid form mixed with incorporating high amounts of foreign imported inputs but also trying to gradually substitute these intermediates. The government heavily supported selected *chaebols* with various initiatives to build stronger domestic backward linkages through the growth of entire strategic backbone industries such as steel, against the advice of international organizations, in contrast with the recent GVC participating developing economies such as Thailand or Vietnam. However, the movement into strategic heavy industries which require large amounts of foreign primary materials and energy, as well as the rise of Korea's electronics and ICT industries characterized by modularity and extreme fragmentation at the global level, have led to a new degree of both backward and forward participation, with forward supply chain trade particularly becoming composed of sophisticated, high-value added intermediate inputs akin to Japan. Key Korean MNCs are now leaders in GVC-intensive products thanks to focusing on many higher value-added activities such as design and R&D in Korea and advanced countries, while minimizing the costs of production partly thanks to offshoring assembly to China, Vietnam, and other export platforms. From this historical basis, one can infer that Korea's backward participation has traditionally consisted of primary raw materials and

energy on the one hand, and high-skill intensive sophisticated inputs on the other, with some low-skill intensive inputs from countries such as China. At the same time, Korea's forward participation may now reflect Korea's increasing convergence with the most advanced economies, as Korea supplies increasingly sophisticated inputs upstream in the value chain, which are relatively high-skill intensive and embodied with leading technology and R&D activities. Although Korea was traditionally positioned between Japan and other developing Asian economies in terms of development as well as in the regional value chain, it has been upgrading toward the higher value added activities located upstream, edging closer to Japan (Ahmad 2013:96; WTO and IDE-JETRO, 2011). Moreover, Korea maintains a strong manufacturing sector and a relatively low service share in its exports contrary to many other advanced economies, but this may partly be due to the manufacturing orientation of Korea's global conglomerates and the degree of in-house service activity prevalent among chaebols. Although the robustness of Korean manufacturing has led some observers to go so far as to claim that the Korean economy has been going through "re-industrialization" as compared to the de-industrialization plaguing many advanced nations, there has nevertheless been a considerable amount of offshoring to developing economies with lower wages, led through both contract outsourcing but also large amounts of outward FDI, with companies such as Samsung, LG, and Hyundai directly owning many overseas factories.

FIGURE 2.33 TRAJECTORIES IN GLOBAL VALUE CHAIN ENGAGEMENT

Global value chain engagement stage	Low-income status	Middle-income status	High-income status
Industry complexity	Simple	Intermediate	Complex
Typical specialization	Commodity production in agriculture, light manufacturing, low value-added services	Advanced manufacturing, agri-business and services	Organization capital, coordination and research and development in complex agri-business, manufacturing and services, branding
Typical market structure and average firm size	Predominantly small firms	Some large, missing middle size in the market likely	Complex market structure with several lead firms and conglomerates and a large and dynamic fringe of small to medium-size firms that interact in complex ways
Buyer–seller relational dependence and governance in global value chains	Market relations (or captive, if supplier competence is low, transactions highly codified, and technological dependence high)	Relational or hierarchical	Highly modular and complex vertical and horizontal relationships of interdependence
Typical firm structure and pool of skills	Few organizational layers, narrow set of capabilities, workforce distribution highly skewed toward production functions	Mid-complexity organization and firm structure	Large firm or conglomerate, quantitatively important middle and higher management and research and development staff relative to production functions
Mode of competition	Price-to-quality competitiveness	Increasingly diversified, nonprice competitiveness	Based purely on brand and value added features in highly specialized areas at the technology frontier

Sources: Engel & Taglioni (2017:131), adapted from Mariscal & Taglioni (2017)

Considering that Korea has reached high-income status, its objectives of global value chain engagement are now moving more towards ensuring sustainable and inclusive growth (Engel and Taglioni, 2017:132). Developing nations also care about equitable distribution, but their initial focus is usually more on growth through trade and GVC participation, which was also the case for Korea in its decades of double-digit growth in the 70s and 80s. However, while Korea miraculously maintained both high growth and relatively low inequality in those early years, disparity in labor market outcomes have continued to rise in the past two decades.

1.7.5 Empirical Literature on the Labor Market Impacts of Globalization in Korea

The wage gap between low and high-skilled labor has worsened in Korea, particularly since after the 1997 Asian Financial Crisis (Ok *et al.* 2007, Bae *et al.* 2013). This has led to a debate in Korea on whether the rise of skill or education premiums has

been due to skill-biased technical change or globalization (Ko, 2011). Due partly to cultural and historical reasons spanning at least centuries, it is general knowledge in Korea that Koreans have put extraordinary weight on improving educational access and attainment levels even amidst extreme poverty or the Korean civil war back in the 1950s. Being resource-poor, Korea's continuous industrial upgrading focused heavily on investment in human capital during the entire development process, with enrollment rates already reaching 90% for primary school in 1964 (OECD, 2016b:14, 29), when Korea was still a highly impoverished nation. The universal expansion of education was one contributor to low inequality during Korea's high growth era, but Korea's relative poverty rate is now ranked 8th among OECD members, while the wage gaps between regular and non-regular workers as well as large conglomerates versus small and medium enterprises are severe, a phenomenon commonly referred to as "labor market dualism (OECD, 2016b:14)." At the same time, the mismatch between education and demand for particular skills in the Korean labor market appears to have worsened, with many students majoring in social sciences or humanities unable to find satisfactory jobs (Cho *et al.*, 2017: 67; OECD (2016b:19)).

One early study re-examining the relationship between particular types of trade on the demand for skills and effects on wage inequality in Korea is Ok *et al.* (2007). The authors focus on the impact of more traditional types of trade (rather than GVC-trade) with China on the employment and wage shares of different skill groups in Korea at the industry level. Distinguishing inter-industry (IIT), vertical intra-industry (VIIT) and

horizontal intra-industry trade (HIIT), the authors find that both types of intra-industry trade have a negative impact on employment. Moreover, vertical intra-industry trade was found to change the composition of skills, separately from the effect of technology. Both types of intra-industry trade led to firms selecting skill-intensive production methods, with HIIT showing similar impacts on both SMEs and large conglomerates, whereas VIIT affected SMEs disproportionately more. Although a limitation of this research is that it is not exactly focused on the context of GVCs in particular, the fact that intra-industry trade[66] showed a skill-biased effect as well as some relatiobship with skill-biased changes in firms' production systems is highly meaningful for the purposes of this thesis.

Around that time, a more GVC-oriented study by Ahn, Fukao, and Ito (2007) examined how intra-regional trade and outsourcing in East Asia affected Korean and Japanese labor markets. Ahn *et al.* (2007) showed that between 1990-2003, intra-regional trade in parts and components within East Asia tripled, while its overall global trade doubled in the same period. Global value chains, offshoring, and subsequent growth in intermediate inputs trade were found to be the main driver behind this intra-regional trade expansion. The authors used gross trade data from UN COMTRADE and industry level data from the Korean Annual Survey of Mining and Manufacturing, as well as labor data from the Basic Statistics Survey of Wage Structure by the Ministry of Labor, and the Economically Active Population Survey by the Korean National

[66] often more linked with GVC-trade compared to inter-industry trade

Statistical Office (KNSO). The Bank of Korea's national input-output tables were used to calculate offshoring measures of foreign intermediate inputs. Ahn *et al.* (2007) found that international outsourcing to China led to a shift in the demand from lower-skilled workers towards high-skilled workers in Korea and Japan, with negative impacts on low-skilled workers, despite Grossman and Rossi-Hansberg's theoretical predictions that suggest that if the productivity effect dominates, offshoring L-tasks can even provide gains for or at least not hurt low-skilled workers. In their study, the productivity effect was not dominant. To reduce these negative distributional impacts the authors suggested policies to increase the relative supply of high-skilled labor by upgrading education and innovation systems.

In a similar vein, Nahm (2010) used data from the Korean Mining and Manufacturing Survey as well as gross trade data from KITA and the Bank of Korea's national input-output table to construct measures of narrow and broad offshoring akin to Feenstra and Hanson (1996, 1999) and Geishecker and Görg (2008). Narrow offshoring was found to significantly aggravate wage inequality between blue-collar (production) and white collar (non-production) workers in Korean manufacturing sectors from 1999-2006, while broad outsourcing did not show significant results. Nahm (2010) suspected that this could be due to a reduction in the relative demand for low-skilled workers in Korea from materials offshoring, but not services offshoring (which would comprise broad offshoring in the case of his study). These two studies contributed heavily to the literature by showing evidence of a skill-biased effect of offshoring through importing

foreign intermediate goods and services but had some limitations. To begin with, being constrained to using first generation offshoring statistics, the studies do not look at Korea's *forward* participation in GVCs, or the exporting of intermediate parts and components to third countries such as China and Vietnam. Moreover, the studies are restricted to using a mix of gross trade data as well as data derived from Korea's national input-output table rather than global input-output tables, due to data limitations at the time of their writing.

As mentioned earlier in this paper, offshoring and trade in global value chains is closely intertwined with the overseas investment activities of global corporations. For instance, it was demonstrated earlier in this chapter that much of the increase of Vietnam's ICT exports were due to the rise of intra-firm trade following Samsung's new investments and factories in the region. Examining the effects of foreign direct investment on labor markets is thus also closely related to GVC participation. In a recent study, Lee and Kim (2018) linked industry-level FDI data with individual-level panel data from the Korea Labor Income Panel Survey to examine how the employment and wages of Korean workers were affected depending on the volume and recipient country of the FDI as well as firm size. They found that outward FDI, particularly to Vietnam, showed highly significant and positive impacts on the employment prospects of Korean workers in large conglomerates. The authors suggested that this may be partly due to the firm hiring more permanent workers in managerial or technical jobs, as productivity improved. However, these FDI outflows, especially again to Vietnam, put downward

pressure on the wages of Korean workers, regardless of the size of their workplace. This study shows how labor market adjustment in terms of employment or wages can show different results. A highly interesting aspect of their findings is that the location of the FDI recipient matters. Since this is due to the heterogeneous qualitative characteristics of investment depending on the partner, the same logic should apply to offshoring and trade in intermediate inputs.

Bae, Sun, Kim, and Lee (2013) published a much more comprehensive and recent study on how exposure to trade influences demand and supply for skills and wage inequality. Bae *et al.* (2013) found that the relative demand for high-skilled labor in manufacturing (university graduates and white-collar workers) increased during 1993-2010, while unskilled workers' conditions deteriorated. The authors reorganized pooled cross-sectional individual wage data at the ISIC 2-digit level for panel analysis, also looking only at manufacturing industries. They focused on the proportion of skilled workers employed compared to total employed labor, as well as the proportion of skilled workers wages in total wages. Their hypothesis was that if outsourced intermediates are substitutable with Korean skilled labor, it would reduce Korean skilled workers' employment and wage share, whereas if it complements Korean skilled workers, there would be positive employment and wage effects (*ibid.*, 2013:130). The authors stated that skill-intensive inputs imported from advanced countries generally reduce the proportion of Korean skilled labor, whereas labor-intensive intermediates from developing countries would reduce relative demand for low-skilled labor in contrast with

high-skilled labor. Of course, the authors admit that this only considers substitution between labor, and that it could be the case that using high-skill intensive inputs for creating final products or high-tech inputs in forward participation in GVCs may demand even more skilled labor. Their hypothesis was therefore more focused on labor substitution rather than potential dominating productivity effects leading to higher wages, but they were aware of the productivity improving aspects of offshoring dealt in the Grossman and Ross-Hansberg (2008) framework. Thus, Bae *et al.* (2013) also acknowledged that the relationship between imported inputs and skills is an empirical question that depends on the context. Their results ultimately suggested that the main culprit behind worsening inequality in Korea changed from skill-biased technical change up to the mid-2000s, to international trade itself in the following period. According to Bae *et al.* (2013:94), Korea's key exports changed dramatically into skill and technology intensive goods, and final demand for Korea's exports shifted from not just advanced economies but also a variety of export-platform developing countries in Southeast Asia, as well as China. This qualitative change in the nature or contents of Korea's trade is, according to the authors, one of the main reasons for the skill-biased impacts of trade after the mid-2000s. The period coincided with a rapid growth in Korea's participation in preferential trade agreements such as FTAs, along with China's entry into the WTO system. Bae *et al.* (2013) state that when examining Korea's trade with its 13 main trade partners in gross terms, the share of imported intermediate inputs from the U.S. fell from an average of 30% in the 1990s to 11% in 2011 (with similar findings for Korea-Japan), while the proportion of inputs from China rose from 10% in 1999 to 34% in 2011. Thus,

trade in intermediate goods, in which advanced technology may be embodied, was shown to facilitate transfer of foreign technology and skill upgrading, while also showing heterogeneous labor market impacts depending on the trade partner. Trade in intermediates with the US or Japan mostly substituted Korean high-skilled workers, whereas international outsourcing to China was biased toward high-skilled workers against low-skilled workers. This result is similar to Lee and Kim (2018) who found different effects of FDI depending on the partner country.

The findings of Bae *et al.* are particularly important for this thesis because it supports the qualitative analysis in this chapter that the composition of Korea's trade has indeed transformed in line with the growing expansion of GVCs in the past two decades as well as Korea's upgrading into high-skill intensive business functions that capture more value added. Moreover, although the study did not specifically examine backward and forward supply chain trade separately, the empirical results suggested that high-skill-intensive inputs imported from advanced countries such as the U.S. or Japan as well as low and medium-skill intensive inputs from China generally had a stronger substitution effect rather than productivity effect for both high-skilled workers and low-skilled workers respectively. This has important implications for constructing hypotheses on how GVC-related trade in intermediate inputs may impact Korean workers' wages in this thesis, as my data examines a time frame starting from 2009, which overlaps considerably with the time period coinciding with the qualitative transformation in trade

content mentioned by Bae *et al.* (2013).[67]

All of these studies provide important insights into how various sub-components of globalization, such as particular types of trade, offshoring, and foreign direct investment have affected the Korean labor market. However, although the studies show an overall increasing awareness of the spread of global value chains, none of the studies explicitly examine the impact of globalization through the lens of GVC participation. This results in a remaining and significant gap in the empirical literature, as these earlier papers have limitations in more precisely characterizing international fragmentation of production. For instance, the studies resort to measures of either traditional forms of trade or first-generation offshoring statistics, and the majority of previous studies only include manufacturing workers in the sample, are conducted at the industry level, and examine time periods in which Korea's trade may have heterogeneous composition from today. This has of course been mostly due to limitations in data as well as the nascent nature of the contemporary literature on global value chains – frameworks formally defining backward and forward participation as well as value added exports have only emerged in this decade. Nevertheless, a common theme behind these empirical studies on Korea seems to be that labor substitution effects are generally stronger than complementary productivity effects when offshoring occurs, either separately or complementary with skill-biased technical change, ultimately leading to negative distributional impacts and

[67] As underlined by Bae *et al.* (2013), the examined time frame is part of the period following China's accession to the WTO, but it is also a time of GVC consolidation and restructuring of world trade following the global financial crisis and great trade collapse in 2008

worsening wage inequality. At the same time, results are not clear-cut due to the heterogeneous effects that appear depending on the partner or measure used, showing some remaining ambiguity.

In the past few years, some empirical works that explicitly consider the remaining gap in the literature have emerged, particularly regarding the usage of more accurate depictions of global value chain trade such as forward GVC participation and value-added trade data. Kim (2016), noted that GVCs and FDI are dominated by large conglomerates, and focused on strategies for improving Korean small and medium enterprises' access to cross border supply chains so that they can also benefit from the productivity effects of GVC participation. Chung (2014) looked at a more macro level and found that value-added exports contributed to higher growth in Korea's GDP. In the specific context of labor markets, Chung (2014) also found that the contribution of intermediate input exports were higher than final goods, as well as evidence that vertical specialization of production has increased the relative demand for high skilled Korean workers as opposed to middle or low skilled labor, who were substituted with workers overseas. Since forward GVC participation comprises a subset of intermediate input exports, this implies that forward participation may have a skill-biased impact in line with the earlier empirical literature on how substitution effects seem to outweigh complementary productivity effects. Chung (2016) followed the empirical methodology of contemporary GVC research such as Johnson and Noguera (2012) and Timmer *et al.* (2013) to specifically examine how GVC participation influenced changes in overall

share of income and employment in the Korean manufacturing industry between 1995-2011, using data from the World Input Output Database (WIOD) to calculate value added exports of domestic and foreign sectors. He confirmed that GVC participation increased as seen in the widening gap between conventional gross exports and value added exports, and that GVC participation changed the composition of employment and value added, reflecting shifts in comparative advantages. These transformations were seen to be a cause behind worsening wage inequality in Korea. The methodology of Timmer *et al.* (2013) and Chung (2016), which uses global input-output tables to calculate the overall share of income going to workers of distinctive skill categories in various industries, provides useful insights in looking at aggregate changes in skill composition, employment, and income in the overall economy. Chung (2016) thus contributed to filling part of the gap in the literature on GVC participation and labor markets in Korea by showing some aggregate level evidence that an increasing number of Korean jobs relying on foreign demand are composed of high skilled workers. This can be seen as some evidence of skill-biased specialization in value added activities that are relatively skill-intensive.

However, although useful in examining aggregate trends (Chung 2016), these macro-level studies are less useful in more finely identifying how specific types of GVC participation directly affect workers' wages as compared to micro-level studies commonly used in assessing labor market impacts. To the best of the author's knowledge, Choi *et al.* (2015) is the only previous study that examines the impact of GVC

participation on the wages of individual workers at the micro level.[68] The total GVC participation index was only available for a few years at the time of their writing, so they estimated separate cross-sectional regressions for three years (1995, 2000, 2009).

The methodology was similar to Geishecker and Görg (2008) in combining industry level data with wage data of individual male manufacturing workers aged 18-60, which were derived from the Survey Report on Labor Conditions by Employment Type of the Korean Department of Labor and Employment and the Local Area Labor Force Survey of the Korea National Statistical Office (Statistics Korea). The main difference between the two studies (aside from using cross-sectional data rather than longitudinal data akin to Geishecker and Görg, 2008) is that instead of using the first-generation offshoring indices of Feenstra and Hanson (1996b, 1999), Choi *et al.* (2015) used the total GVC ratio – which as mentioned earlier, is a contemporary indicator that overcomes the limitation of only looking at backward participation or the foreign value added embodied in gross exports by also incorporating domestic value added sent to third countries. The advantages of the GVC indices also include the fact that they are measures of importing to export rather than just importing to produce. In any case, the main finding of Choi *et al.* (2015) was that total GVC participation showed a skill-biased effect, boosting the wages of high-skilled workers more than low or medium-skilled workers. Thus, this study contributes considerably to filling the literature gap in terms of more accurately

[68] A paper by Choi (2016) also exists, but it is mostly a summarized English version of a portion of the original Choi *et al.* (2015) report which was written in Korean

analyzing the effect of GVC participation through a more encompassing contemporary indicator. Nevertheless, the study was constrained by data limitations – the Korean labor data set used by Choi *et al.* was selected due to its accuracy of wage data, but it is cross-sectional, and at the time of their study, the OECD's GVC participation indices were only released for a few years. The limitations of the data could be a reason for the exclusion of many control variables as well as the weakly significant coefficient estimates. Furthermore, because the study relies on cross-sectional measures for the year just after the global financial crisis of 2008, there could be a number of confounding factors, and the sample was constrained to only manufacturing workers, neglecting the role of services in GVCs. Most importantly, the study did not distinguish between forward and backward GVC participation, which were shown to have clearly heterogeneous impacts according to López-González *et al.* (2015). Nevertheless, this study was the first to integrate individual level micro wage data with industry level data using the GVC participation indices, a significant contribution amidst a much larger body of work using more conventional measures of trade or first generation offshoring statistics. In light of the fact that these country-specific findings conflict with López-González *et al.* (2015)'s suggestion that countries with higher GVC participation have less inequality, further examination on how heterogeneous types of GVC participation may have affected Korea's labor market using more robust methodology is imperative.

To sum, this chapter has demonstrated the disproportionately crucial role of Korea in both Asian and global value chains. Furthermore, a careful qualitative analysis of the

developmental history of Korea and its industrial upgrading was used to show how the composition of Korea's imports and exports, particularly in terms of cross-border supply chain trade, may have increasingly embodied high-skilled tasks and higher value-added intangible activities associated with the upper sections of the smile curve. This observation was supported with recent empirical work on the composition of Korea's intermediate goods trade as well as offshoring activities and FDI. Some of the empirical research suggested skill-biased effects favoring high-skilled workers, but there remained considerable differences in results depending on the data, years and particular trade / investment partners examined, indicators used, as well as a number of other qualitative characteristics that may underline the particular form of globalization examined in each paper. Although acknowledging the increasing role of international fragmentation of production, almost all existing studies were limited to using conventional or first-generation trade and offshoring statistics, limiting their applicability to accurately examining the impact of global supply chain trade on labor markets.

One recent study by Choi *et al.* (2015) did explicitly examine the micro-level labor market impacts of total GVC trade on manufacturing wages, but its finding was opposite to the cross-country findings of López-González *et al.* (2015) which stated that more GVC participation was related to less inequality. This shows that the inherent limitations of single-country empirical studies in international comparability can also act as potential strengths in the context of GVC trade: if forward and backward supply chain trade have heterogeneous impacts on labor markets depending on the country in question,

aggregating the labor market outcomes of many countries may rather be misleading. Indeed, it could be the case that the relationship between what kinds of skills are embodied and substituted in backward and forward GVC participation are different depending on each country's unique situation. Furthermore, the relative strength of the productivity effect versus labor substituting effects can also be different depending on the context, leading to further ambiguity on the degree of skill-bias that may exist for both types of GVC participation depending on the country. Thus, attempting to find some causal effect or at least clear correlation between different types of GVC participation within one country may provide even more meaningful insights for researchers, as the unique institutional, labor market, and industrial characteristics of the country in question can be considered in isolation. For instance, this thesis demonstrates in the following chapter that defining workers' skills according to international ISCED criteria can lead to misleading results. This is just one example on how looking at each individual country separately can allows researchers to at least draw better conclusions with respect to the effect of GVC participation on wages within the context of one country, rather than trying to look at the uncertain effects of GVC participation on wages of many countries at once. An accumulation of such single-country studies can then allow researchers to infer what sources of heterogeneity exist among differing countries if they show different signs and impacts of GVC participation on their workers' wages. Despite the importance of Choi *et al.* (2015)'s study, there were still many methodological limitations in terms of data and no separate analysis of forward and backward GVC participation.

Since López-González *et al.* (2015) as well as Farole *et al.* (2018) showed directly contrasting empirical results of forward and backward linkages, this thesis attempts to exploit all the advantages of linking individual worker data with industry-level GVC indicators to determine how, in the context of Korea's development and industrial upgrading dealt with in this chapter, the qualitative characteristics of Korea's forward and backward GVC participation have impacted wages of Korean workers in all industries in the years following the global financial crisis in 2008. The following section thus begins with a summary of hypotheses to be tested based on the discussion of the empirical literature as well as qualitative characteristics of Korea's GVC trade analyzed in this chapter.

2. Hypotheses Formulation

2.1. Model Predictions

Main Research Question: Would Korea's total, forward, and backward GVC participation discriminately affect wages of workers with different skills?

The theoretical models underlying this empirical study underscored the uncertainty on how offshoring and GVC trade may affect wages of low and high skilled workers. For instance, the chapter on labor market impacts of globalization (Section 1.6) demonstrated that in the framework of Grossman and Rossi-Hansberg (2008), offshoring of low-skilled tasks can either increase or decrease the wages of low-skilled workers due to the offsetting forces of the productivity, labor supply, and relative price effects. As an example, López-González*et al.* (2015:13) pointed out that the labor supply effect dominates when skilled labor comprises a large portion of total costs, or when low-skill tasks and high-skill jobs cannot be easily substituted in production. This shows that simple changes in assumptions creates different expectations. More traditional models, on the other hand, focused more on labor substitution effects. In a contemporary context, López-González *et al.* (2015) identified the link between *sending* and *receiving* offshored bundles of tasks with backward and forward GVC participation. Nevertheless, empirical studies using these contemporary indices also showed that both backward and forward participation can have (or not have) skill biased effects, but results changed dramatically depending on the data, countries, and specific methodology. With this in

mind, the most important consideration seems to be what types of tasks and skills are embodied in backward and forward supply chain trade. This section thus considers the work on factors that may underlie skill-biased effects of backward and forward global value chain participation and adds the characteristics of Korea's GVC trade to derive hypotheses on how GVC participation has affected Korea's labor market. Aggregating all of the theories and empirical work on GVC participation in general as well as Korea's GVC trade, offshoring, and industrial upgrading, the expectation of this thesis is that GVC participation in general will show skill-biased effects on the wages of Korean workers, but the degree of the skill-bias will be strongest for forward participation and weakest for backward participation, while total participation should show a somewhat middle position. This is in stark contrast with the recent empirical cross-country analysis of Farole *et al.* (2018), so a decomposition of the rationale underlying these hypotheses is provided.

To begin with, one of the main potential sources of skill bias is increased specialization in high-skill-intensive business functions with higher value added in the smile curve. When firms in developed economies increasingly focus on specializing in the highest value adding intangible services activities, they require skills that are often complementary to high-skilled labor and very different from the skill sets needed in high-quality manufacturing and production functions (Cho *et al.* 2017:250). The question would be whether Korea's backward and forward GVC trade have this tendency. A quick consideration of the qualitative changes in Korea's GVC trade to increasingly

sophisticated upstream technology inputs in the flying geese model suggest that increasing forward participation should strongly embody this type of specialization and business function upgrading. For Korea, backward participation would include a more diverse mix of tasks and skills that may still imply some skill bias, but not as much as forward participation.

As mentioned in the previous chapters, forward participation is the exporting or supply-sell-side of GVC trade. López-González (2017) suggested that increased exports of intermediate goods to third countries allows firms to focus on specific activities of production instead of having to vertically integrate all production stages (López-González, 2017). This means that more forward participation is highly associated with increased granular specialization in business functions – which for Korea was shown to be an increased focus on upgrading to higher value added stages. Korea has been moving more upstream and increasingly selling sophisticated inputs such as semiconductors and OLED displays, and has been maintaining its position as a world leader by focusing on design and R&D functions. This type of forward participation in sophisticated parts and components would embody considerably different skills and tasks as opposed to raw material or energy forward participation trade by countries such as Saudi Arabia, or forward participation in low-skill-intensive parts (by developing economies) which is why a cross country comparison assuming that both types of forward participation would have the same impact on labor markets may be misguided. Downstream economies such as China and Vietnam are receiving offshored activities

from Korea when they import Korean OLED displays to be used in their assembled phone exports (Korea's forward participation). China and Vietnam have thus de-facto offshored high-skilled tasks to Korea in a relative perspective (their backward participation). The problem is that a finer level of specialization in high-skill-intensive business functions was shown to be associated with higher relative demand for high-skilled workers compared to specialization in traditional, whole industry-level specialization that used less skewed distributions of skills (Bacchetta and Stolzenburg 2019:47). Korean firms focusing on higher value added activities are now much more likely to substitute low-skilled labor either with automation or through offshoring to low-cost economies, while the demand for low-skilled inputs from domestic Korean suppliers are also likely to decrease if there is less need to source through domestic backward linkages. Moreover, considering that Korea's exports are generally high-tech as well as capital intensive, it is also likely that the negative impacts of skill-biased technical change are also amplified as Korea's forward participation increases. Since forward supply chain trade in Korea is most focused on these sophisticated high-skill intensive activities as well as capital and technology intensive products, a particularly prominent skill-biased impact on wages seems likely.

In contrast, the composition of Korea's backward GVC participation seems less clear. Korea was shown to have a very high foreign value added content in exports compared to most countries, but this is a result of a mix of highly heterogeneous types of intermediate inputs. López-González (2017) stated that the advantages of backward

supply chain trade accrue from a broader selection of "sophisticated and competitively priced imports", cutting-edge technology, and "inputs that cannot be sourced domestically" (Ganne and Lundquist, 2019). The issue here is that for Korea, "sophisticated" technology inputs, low cost inputs, and inputs that can only be found abroad, are likely to have considerably different impacts on labor markets. Judging from Korea's level of economic development as well as technological sophistication, "inputs that are not domestically accessible" (López-González, 2017; Ganne and Lundquist, 2019) should mostly consist of imports of raw materials, energy, and other primary products, which this chapter demonstrated is largely due to the combination of Korea's capital intensive heavy industry export composition as well as its deficiency in natural resources. These imports should clearly boost the overall productivity of firms, leading to an overall positive wage effect for workers. Since Korea does not domestically produce or export many natural resources,[69] it is less likely that exporting uranium and iron ore from Australia or oil from the Middle East would substitute Korean workers. There may still be a smaller skill biased effect because exporting firms that hire more skilled workers might either automate or offshore more lower skilled jobs as average fixed costs of capital investments decrease when production expands (Farole *et al.*, 2018:6)[70], and there could be disproportionately larger bonuses for the high-skilled or

[69] As an exception, coal and limestone used for cement were mined in the very early stages of economic development, but these industries have declined.

[70] Backward GVC participation, like forward participation could thus also aggravate skill-biased technical change if low and medium skilled tasks are automated while demand for high-skilled workers managing new technologies and production methods increases

medium skilled workers employed by chaebols. It should be noted that the high-wage conglomerates mostly hire high-skilled workers for non-production occupations, while medium-skilled workers consisting of high school as well as 2 year technical college graduates are employed in factories as production workers. If demand for domestic SME suppliers that are relatively less skewed in their workers' skill distributions falls due to substitution with overseas firms,[71] while the exporters (chaebols account for much of exports) enjoy high productivity effects through backward participation (Helpman, Itskhoki, and Redding, 2010), the result could be high boosts to medium and high-skilled workers rather than low-skilled labor, although these substitution effects could be offset to some degree by exporters' productivity enhancements causing more domestic sourcing as well (akin to the findings of Antras *et al.*, 2017).

On the other hand, another important component of Korea's backward participation has been sophisticated high-tech inputs from the most advanced economies such as Japan and the United States. Offshored high-skill business functions from Korea to these nations would be embodied in these intermediate imports of parts and components. Following the logic of Grossman and Rossi-Hansberg's (2008) trade in tasks model, this would not necessarily cause high-skilled workers wages to fall, since there would be simultaneous positive productivity effects against negative labor supply effects, but this would clearly boost the wages of medium skilled labor employed in

[71] Few low-skilled workers are hired in chaebols – many rather work in SMEs or low-skill intensive service sectors

exporting firms. Low-skilled workers may also indirectly enjoy some benefits as overall economic productivity expands.

Last but not least would be Korean backward participation in non-sophisticated low-skill-intensive inputs from developing countries such as China. Since this is effectively offshoring of low-skilled tasks, this would most likely disproportionately boost high-skilled workers' wages relative to low or medium-skilled labor, although again, the productivity effects may partially offset substitution effects, which means that one cannot confidently expect that the wages of low or medium-skilled workers would show negative coefficients.

In short, the aggregated effect of Korea's backward participation in sophisticated inputs, low-skill parts and components, as well as primary raw materials and energy would likely show a relatively ambiguous outcome compared to forward participation. This thesis hypothesizes that backward participation would boost overall wages, but there would be a relatively weak skill-biased effect compared to forward participation. In particular, the expectation is that high and medium-skilled wages would diverge less than other forms of GVC participation, while low-skilled labor left out of increasing productivity in exporting firms would benefit less. This could be aggravated if there is an overall lower need for low-skilled workers in Korea's domestic backward linkages (not necessarily exporting firms but suppliers of firms), but due to offsetting effects it cannot be expected with certainty. In any case, these hypotheses regarding the impacts of backward GVC trade on Korea's labor markets directly contrast with the

empirical result of (Farole *et al.*, 2018). However, the underlying logic is that Korea's backward participation does not only comprise offshoring of low-skilled jobs to low-income economies (which seems to be one of the main factors identified by Farole and others on why backward participation from advanced economies was skill-biased), since high-skill-intensive as well as primary inputs comprise even more important roles for the nation's imports. As a clear example, Samsung exporting semiconductors to its factories in Vietnam, and Vietnam importing these inputs from Korea to assemble and re-export to the U.S. comprise forward participation for Korea, while the high-skill intensive photoresists imported from Japan and needed to produce semiconductors comprise Korea's backward participation.

Finally, since total GVC participation is the sum of forward and backward participation, it seems logical to expect an overall skill-biased effect a long as there actually is such an effect for both types of GVC trade. Aside from the simple relation with specialization in higher value added business functions, some characteristics of GVC participation such as the allocation of workers to more productive exporting firms (which hire more high-skilled workers, see Helpman *et al.*, 2010)) and interaction with skill-biased technical change also rationalize expectations for skill-biased impacts regardless of the type of participation (Bustos, 2011). For instance, since upgrading into complex and sophisticated tasks as well as the goods and services which are the outcome of these production activities are often related to developments in technology as well, there may well be a close relationship between skill-biased technical change and GVC

participation. In addition, it is increasingly difficult to disentangle the effects of skill-biased technical change and GVC participation due to the fact that workers performing routine tasks that are most offshorable are also facing the highest risk of automation (OECD, 2013). Hollweg (2019) states that industrial organization of production activities becomes more complex when GVCs expand, Furthermore, there is more demand for high-skilled managers with both technical and soft skills capable of coordinating value chain activity, as well as a rising role of business services such as finance and communication (Cho *et al.* 2017:250; Hollweg 2019). This may lead to an overall skill-biased effect favoring university educated workers regardless of the type of GVC participation, which is one of the key reasons that this thesis hypothesizes that all three types of GVC participation will boost the wages of high-skilled workers.

In short, whether through amplifying the effects of trade, offshoring, and productivity, skill-biased technological change, or simply from creating more complementary demand for high-skilled workers through GVC-specific characteristics, GVC participation seems likely to show a skill-biased impact on wages. Nevertheless, the qualitative characteristics of Korea's backward and forward supply chain trade implies a different outcome from the recent cross-country study of Farole *et al.* (2018). This chapter thus concludes with a summary of hypotheses.

2.2 Summary of Hypotheses: Prediction of Wage Effects

Hypothesis 1a: *There is a positive association between the skill level of individual workers (measured by educational attainment) and their average monthly wages, i.e. there exists a wage premium on education.*

Hypothesis 1b: *There is a positive correlation between the degree of participation in global value chains at the industry level and the average monthly wages of labor working in those industries that are more integrated into GVCs.*

Hypothesis 1c: *There is a stronger effect of hypothesis 1b for high skilled workers compared to medium or low skilled labor. In other words, global value chain participation has a bias which favors high-skilled labor, where the boost in wages caused by deeper GVC integration at the industry level is larger for high skilled workers than workers with lower levels of educational attainment*

Hypothesis 2a. *Backward GVC participation would also boost productivity and thus overall wages, but its skill-biased effect would be weakest*

Hypothesis 2b. *The skill-biased effect of forward GVC Participation is strongest*

Hypothesis 3a. *A lower sector-level value added export (VAX) ratio correlates with higher wages (moves in opposite direction of GVC indices)*

Hypothesis 3b. *There is a skill-biased impact of more production fragmentation indirectly measured through lower VAX ratios (less expected than GVC indices due to limitations of sector-level VAX ratios in measuring GVC participation)*

Hypothesis 3c. *Alternative measures such as time lagged GVC trade variables should show consistent results*

III. DATA AND EMPIRICAL METHODOLOGY

1. Data Sources and Sample

1.1. OECD-WTO Trade in Value Added (TiVA) Indicators

This thesis has examined the concept of value added trade and its new implications for revealing the ultra-interconnectedness of today's world economy in considerable detail. As mentioned earlier, there are several different databases that provide estimates of trade in value added. Among the various options, this study uses the most recently updated December 2018 version of the OECD-WTO Trade in Value Added (TiVA) database to construct the four contemporary measures of GVC participation explained in Chapter 2: the total, forward, backward participation indices as well as the Value Added Export (VAX) ratio.

As UNCTAD (2013) notes, an advantage of the OECD TiVA database is its careful attention to statistical rigor, while other global input-output databases such as Eora have the advantage of covering more countries. However, the most recent December 2018 version of the OECD-WTO TiVA database has been expanded to cover many more countries and years compared to earlier editions, which strengthens the advantages of using OECD TiVA and minimizes the costs of less coverage of countries. For instance, the first release of TiVA in 16 January 2013 covered only three years (2000, 2005, and 2008) and a limited number of countries. Thus, the OECD and WTO released an update on 17th May 2013, so that the indicators would cover 59 countries, 18

industries, and two more years (1995, 2000, 2005, 2008, 2009). Even at that time, approximately 95% of world production was incorporated into the OECD ICIO model (the underlying database for calculating TiVA indicators, see De Backer and Miroudot, 2013:10-13). After another update in 2016 to cover 61 economies and 34 industries based on the 3rd Revision of the International Standard Industrial Classification (ISIC Rev.3)[7273], the most recent **2018 database** now covers the years **2005-2015** and a total of **64** countries including all major OECD, EU, and G20 economies as well as many developing Asian countries that play a crucial role in GVCs. Indicators are also newly disaggregated to **36** industries based on the newly revised ISIC Rev.4.[7475] This thesis therefore has an advantage compared to previous studies in Korea that used earlier versions of OECD TiVA that only allowed analyses based on a limited selection of years and countries. For instance, Choi *et al.* (2015), which is the only existing study that has examined the impact of Korea's industry-level GVC participation on individual-level wages, was constrained to using only three years and only total participation presumably due to these data limitations. The reason that the TiVA indicators for years before 2005 are not included in this study is because there are considerable discrepancies in the

[72] https://www.wto.org/english/news_e/news16_e/stat_28jan16_e.htm,

[73] WTO (2016) "'Trade in Value-Added and Global Value Chains' profiles Explanatory notes" 2016 version, https://wto.hse.ru/data/2016/02/01/1137030336/Explanatory_Notes_e.pdf

[74] OECD (2019), "Trade in value added", OECD-WTO: Statistics on Trade in Value Added (database), https://doi.org/10.1787/data-00648-en (accessed on 22 July 2019).

[75] WTO (2019) "'Trade in Value-Added and Global Value Chains' profiles Explanatory notes" 2019 version, https://www.wto.org/english/res_e/statis_e/miwi_e/Explanatory_Notes_e.pdf

methodology that was used to construct previous versions of TiVA compared to the most recently updated database.[76] Data in the new TiVA database is based on the 2008 System of National Accounts (SNA) as well as ISIC Rev.4, which allocates data on various activities differently from the previous SNA 1993 and ISIC Rev.3 specifications. To mention some easily noticeable differences due to this new collection of data, backward GVC participation has fallen for the majority of countries, and industries are classified differently – there are now 36 instead of 3, with some categories newly separated or combined together. The inclusion of only 2005-2015 is nevertheless not a serious problem, as the KLIPS worker data used in this study also requires researchers to select either a sample tracked from 1998 or one that begins in 2009, with 2009 having better representativeness and a larger data set. Matching the two data sets makes the research focus on the period after 2009, the start of a new period of re-consolidation of GVCs following the global financial crisis. This strengthens the homogeneity of the qualitative characteristics of GVC participation and offshoring in the examined years, which may in fact improve methodological robustness. In any case, to the best of the author's knowledge, this thesis is the only existing research that examines the impact of four types of GVC participation on an individual panel data set spanning multiple years, based on the most recent and accurate treatment of value added trade data, furthering the contribution of this study in filling the gap in the empirical literature.

[76] See "What's New? Differences between the 2018 and 2016 editions of TiVA indicators" (Draft, December 2018) http://www.oecd.org/industry/ind/tiva-2018-differences-tiva-2016.pdf for a more detailed discussion

1.2. Korea Labor Income Panel Survey (KLIPS)

KLIPS (Korean Labor & Income Panel Study) is the *only* "longitudinal survey of the Korean labor market that looks at the income activities of households and individuals residing in urban areas."[77] The survey "annually tracks 5,000 households and their 13,000 members distributed nationwide" (KLI 2018:1-20). KLIPS includes two samples: an original sample that starts from the 1st wave launched by the Korea Labor Institute (KLI) back in 1998, as well as a newer consolidated sample which was tracked since the 12th wave in 2009. The newly expanded sample added 1,415 households and residents of Jeju Island to deal with sample attrition as well as to better represent the entire country's population (KLI 2018:2-4). This thesis uses the newest version of KLIPS, released in December 2018 by KLI. The version covers up to the 20th wave survey which spans 2017.[78] As of 2017, 67.1% of households were retained in the 1998 original sample, while the 2009 new consolidated sample maintained a retention rate of 84.4% (5,674 households and 13,774 individuals) (KLI 2018:8). According to KLI (2019),[79] KLIPS data is reliable because the majority of core indices show similar values to official reference government statistics.

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[77] Korea Labor Institute (KLI) Website https://www.kli.re.kr/klips_eng/contents.do?key=251

[78] As of the 10th of July, 2019, only a Korean version is available - the English version of the data only covers up to the 19th wave of 2016.

[79] *Frequently Asked Questions: How to Estimate the Number of Irregular Workers Using the KLIPS Data* https://www.kli.re.kr/klips_eng/selectBbsNttList.do?bbsNo=70&key=413

TABLE 3.1: KLIPS SAMPLE DATA

	98 Original Sample					Consolidated Original Sample				
		Survey Target	Successfully Surveyed Households		Household Members		Survey Target	Successfully Surveyed Households		Household Members
	Original-Vanished House-holds	No. of House-holds	Original Sample House-holds	Retention Rate of OSH	No. of Surveyed Members	Original-Disappeared Households	No. of House-holds	Original Sample House-holds	Retention Rate of OSH	No. of Surveyed Members
1998 1st Wave	5000	5000	5000	100	13321					
1999	5000	4507	4378	87.6	12037					
2000	5000	4266	4044	80.9	11205					
2001	5000	4248	3866	77.3	11051					
2002	5000	4298	3798	76	10966					
2003	4993	4592	3862	77.2	11541					
2004	4949	4761	3862	77.2	11660					
2005	4935	4849	3822	76.4	11580					
2006	4914	5001	3820	76.4	11756					
2007	4899	5069	3775	75.5	11855					
2008	4862	5116	3710	74.2	11734					
2009 12th Wave	4833	5306	3658	73.2	11739	6721	6721	6721	100	14489
2010	4803	5379	3607	72.1	11582	6694	6398	6232	92.7	13641
2011	4787	5404	3528	70.6	11376	6676	6388	6082	90.5	13409
2012	4771	5469	3517	70.3	11442	6641	6434	6016	89.5	13426
2013	4742	5501	3472	69.4	11330	6597	6457	5904	87.8	13303
2014	4742	5552	3451	69	10756	6589	6493	5840	86.9	12595
2015	4702	5632	3421	68.4	11445	6530	6577	5793	86.2	13372
2016	4687	5714	3393	67.9	11652	6505	6634	5728	85.2	13520
2017 20th Wave	4670	5761	3355	67.1	11880	6475	6685	5674	84.4	13774

Source: Author's Translation and Adaptation from KLI (*2019 Overview*)

Moreover, since all other national surveys on the Korean labor market are cross-sectional,[80] research based on KLIPS can benefit from being able to exploit the methodological advantages of longitudinal studies. Longitudinal or panel data surveys combine the advantages of cross-section and time-series data, allowing the examination of both *between (or among)* and *within* variation of observations as well as dynamic changes. When fixed effects are used, panel data allows researchers to control for unobservable heterogeneity in the panel dimension (in the case of KLIPS, it is typically the individual level) (Baltagi 2014). Thus, this study benefits from being able to use panel data compared to other studies which were conducted on cross-sectional labor market data such as the only existing previous study using a similar methodology by Choi *et al.* (2015).

As shown in **Table 3.1**, researchers must select one of the two samples spanning different years in KLIPS: the 1998 original sample, which surveys more years, or the 2009 consolidated sample, which is shorter but has better representativeness and larger dataset. Partly due to the fact that the most recent OECD TiVA data on GVC participation spans 2005-2015, this study uses the larger and more recent consolidated sample starting from 2009 in the 12th annual survey.

[80] The Korea Labor Institute (KLI) lists "the Current Population Survey and Special Survey of Employment by the Korea National Statistical Office; the Survey of Labor Mobility and Basic Survey of Wages by the Ministry of Labor" as examples of cross-sectional surveys on the labor market

2. Econometric Analysis

2.1 Baseline Panel Regression Wage Equation Model

To examine the effect of sector-level GVC participation on individual workers' wages, it is crucial to control for numerous other explanatory variables that may also affect the labor market outcomes of each individual. The Mincer human capital earnings function (1958, 1974) has been widely used in empirical labor economics to estimate the rate of return on educational attainment on workers' wages. It is easy to adapt this equation to control for other factors such as work experience, making it appropriate for the econometric analysis in this paper. Thus, in order to examine the heterogeneous effects of GVC participation on the wages of workers with different skills, the following econometric analysis in this thesis estimates panel regression models based on variations of the Mincerian wage equation of the following form[81]:

$$\ln wage_{ijt} = \alpha + \beta X_{it} + \gamma GVCP_{jt} + \delta EDUC_{it} + \lambda GVCP_{jt} * EDUC_{it} + \ldots + \varphi_t + \varepsilon_{ijt},$$

[81] The author notes that this is similar to the idea underlying Geishecker & Görg (2008, 2013) and Choi *et al.* (2015). Nevertheless, there are many important differences between the empirical model used here as opposed to previous studies combining industry-individual measures. My main independent variables are total, forward, and backward GVC trade and sector-level VAX ratios rather than the offshoring index proposed by Feenstra and Hanson (1996). Choi *et al.* (2015) did use the total GVC ratio but did not distinguish forward and backward types nor use VAX. Moreover, the sample is quite different: considering the crucial role of services in GVCs, individuals working in services and agriculture, as well as females, are all included in contrast to the previous works. To add, Choi *et al.*'s analysis is cross-sectional in terms of time. Many other differences are not explicitly noted here to save space.

where subscript *i* denotes individuals, *j* indexes industry (KSIC matched with 36 two-digit aggregations based on ISIC Rev.4), and *t* denotes time. The dependent variable $\mathbf{ln}\boldsymbol{wage}_{ijt}$ is the natural logarithm of the average monthly wage of an individual worker *i* working in industry *j* in year *t*. $\boldsymbol{X}_{it}$ is a vector of many typical individual-specific control variables, including age, age squared, job tenure, tenure squared, gender, labor union membership, and permanent or regular worker status. Other individual and workplace characteristics such as marital status, firm size, as well as dummy variables for geographic region and occupational status are also included in some of the specifications. $\boldsymbol{EDUC}_{it}$ denotes the educational attainment of an individual *i* in year *t* and is used as a proxy for measuring skill levels. The reference or base category is the low-skill group of workers. $\boldsymbol{GVCP}_{jt}$ includes various indicators of Korea's participation in GVC-related trade as a share of gross exports to the world for industry j in year t, including the total, forward, backward GVC participation indices as well as the sector-level VAX ratio.

The product term $\boldsymbol{GVCP}_{jt} * \boldsymbol{EDUC}_{it}$ is constructed in order to measure whether increased GVC participation has a skill-biased impact on wages of workers in different skill categories. This is the main explanatory variable of interest, as it examines whether an increase in GVC participation at the industry level gives a higher positive boost to an individual's wages depending on their skill level. Following this study's $\boldsymbol{\lambda}$ should therefore be positive ($\boldsymbol{\lambda} > 0$) for the GVC participation indices and negative for the VAX ratio ($\boldsymbol{\lambda} < 0$). On the other hand, if the statistical analyses suggest that there is no

observable functional relationship between GVC participation and individuals' educational attainment, we would not be able to reject the null hypothesis that GVC-related trade uniformly impacts workers of different skill levels ($\boldsymbol{\lambda} = 0$). $\boldsymbol{\varphi_t}$ refers to year or time fixed effects that control for price effects as well as economy-wide changes in business cycles or technological progress. This term is mainly included to control for factors such as inflation, as the wages in the dependent variable are expressed as nominal Korean won, rather than real wages. Some of the changes in overall technology levels are also captured by the year dummies. $\boldsymbol{\varepsilon_{ijt}}$ is the error term. Some specifications include individual fixed effects to control for other unobserved heterogeneity but doing so is highly problematic due to the time-invariant nature of the main skill variable. As a limited remedy, this study reports robust standard errors adjusted for clustering in the panel dimension, or the individual worker. A more detailed discussion of this issue, as well regarding the other control variables will be provided in the following sections.

3. Variable Construction

3.1 Constructing Variables from KLIPS

The KLIPS sample used in the econometric analysis consists of wage earners in *all* industries (not just manufacturing) aged 18 to 60 years old from year 2009 to 2017. Employers, self-employed, and non-paid family workers are left out of sample. KLIPS defines wage earners as workers who are "employed by others or a company, receiving

wages or salaries (full-or part-time)[82]." In contrast, non-wage earners are divided into either employers or self-employed workers who "own and manage a business with or without hired workers" or unpaid family workers who work "for a family business 18 hours or more per week." Wage earners are restricted to employed workers, while those defined as unemployed or economically inactive based on ILO standards are not included. Contrary to many earlier studies using a similar empirical methodology, the sample is not restricted to males or permanent/regular workers – instead, these groups are assigned dummy variables. It should be noted that one of the few variables in KLIPS that has a large discrepancy with "*the Economically Active Population Survey*[83] is the proportion of irregular workers. The reason for this is apparently the different methodology in defining work status between the two surveys. KLIPS uses less stringent measures, simply allocating workers with work contracts of 1 year or more as regular workers, while those with shorter contracts are categorized as temporary (1 month to shorter than 1 year), or daily. On the other hand, the official Statistics Korea survey supplements this simple allocation with additional criteria such as whether workers experience workplace discrimination in terms of labor regulation and eligibility for other benefits and perks. Even if contracts are long, discriminated workers are re-categorized into irregular labor. KLIPS is overall well-suited for the purposes of this study, however,

[82] All definitions used in this section are derived from the KLI website, KLIPS User′s Guide (Waves 1-20th), or official KLIPS questionnaire

[83] KLIPS states that this survey, which is conducted by Statistics Korea, serves as the standard when discussing the share of irregular workers.

and this study assumes that the discrepancy in number of workers in this particular variable should not cause a significant change in overall regression results.

The firm size control variable is divided into three dummies: *large* refers to workplaces with 300 employees or more, *medium* included firms with 100~299 workers, and establishments with less than 100 people are the reference category. The variable measures the total number of workers in the company, including the headquarter, other branches (if the company has several affiliates), and factories. The region dummies include 16 metropolitan areas and provinces,[84] as well as a small number of extra observations in Sejong. North Koreans and overseas Koreans are not included in the sample.

9 dummy variables are created as occupation controls based on the nine main categories of the 2007 6th revision of the Korean Standard Classification of Occupations (KSCO Rev.6).[85] The first category is "managers", which comprises occupations such as senior corporate or public officials or other managers in business administration, among many others. The second is "professionals and related workers." Some examples are engineers, programmers, doctors, professors, or lawyers. The third category is "clerks," for example information desk receptionists. Fourth are "service workers" such

[84] Seoul, Busan, Daegu, Daejeon, Incheon, Gwangju, Ulsan, Gyeonggi Province, Gangwon Province, Chungcheong North Province, Chungcheong South Province, Jeolla North Province, Jeolla South Province, Gyeongsang North Province, Gyeongsang South Province, and Jeju Island

[85] Published by Statistics Korea, http://kssc.kostat.go.kr/ksscNew_web/ekssc/main/main.do

as hairdressors, waiters, and bartenders. Fifth are “sales workers”, sixth are “skilled agricultural, forestry and fishery workers”, and seventh are “craft and related trades workers,” which includes a variety of jobs such as textile and furniture workers, mechanics, and plumbers. The eight category is defined as “equipment, machine operating and assembling workers,” with examples such as taxi, bus, and train drivers. The final ninth category encompasses “elementary workers,” who may work in construction, mining, fast food, delivery or housekeeping and cleaning. It also includes workers in agriculture, forestry and fishery who are not classified as “skilled” in the earlier sixth category.

3.3 Skills & Educational Attainment Variables

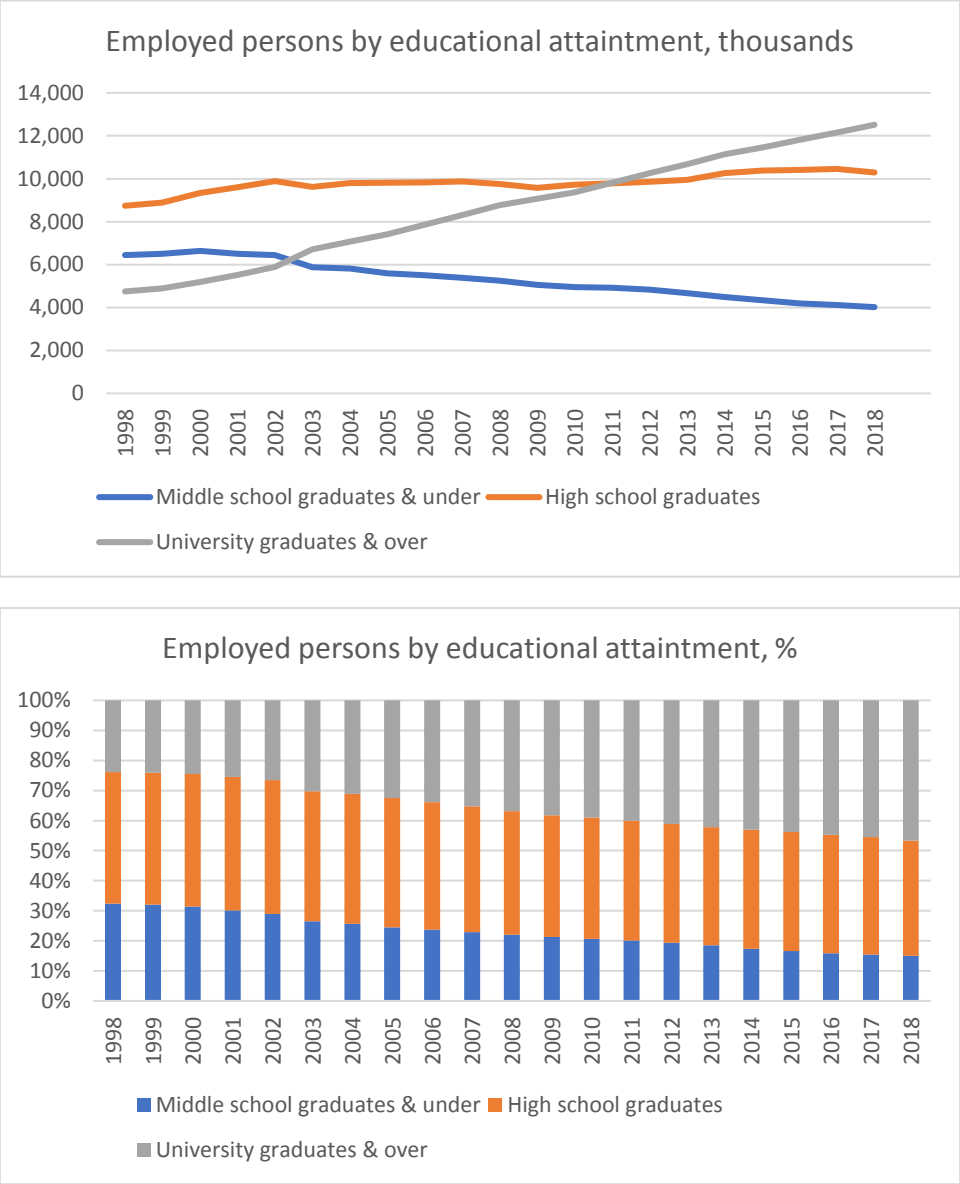
Special attention is given to constructing the education group indicator variable, which is used as a proxy for the skill level of labor. Th skill variable is divided into three dummy variables for education (high, mid, and low), which are defined to better reflect Korea’s particular education standards. In Korea’s educational system, elementary or primary school is 6 years, middle school or lower-secondary education, as well as high school / upper secondary education are also three years each. Tertiary education is divided into 2-year colleges and 4-year universities (some majors such as medical school take 6 years). In this study, low skilled labor is defined as workers who have up to middle school (primary and lower secondary) diplomas, while medium-skilled workers consist not only of high school graduates and students still in university, but 2-year college graduates as well. This contrasts with the International Standard Classification of Education (ISCED)

standard, which includes 2-year college graduates in the high-skilled category while including only high-school graduates in the medium-skilled category. It is emphasized that 4-year university graduates and above are classified as high-skilled in this research. This approach is similar to Choi *et al.* (2015). The main reason for this is due to a phenomenon that is often referred to as "academic inflation" in Korea, which has an exceptionally high proportion of high-skilled workers compared to international standards (also noted by Bae *et al.* (2013:27), Choi *et al.*, and Cho *et al.* (2017). As shown in **Figure 3.2**, the rapid and continuous increase in educational attainment in Korea has led to the proportion of high-skilled workers surpassing the number of low and medium-skilled workers since 2011. This trend is likely to continue: according to the OECD, 69.8% of Korean young adults aged 25-34 had tertiary education, while only 21.3% of adults aged 55-64 had tertiary education, which was the widest generation gap among the OECD member states.[86] Mirroring the high proportion of the high-skilled population is the relatively small share of low-skilled youth: among all OECD members, both Korean men and women had the lowest share of young adults that only received lower secondary (or under) diplomas.[87] The continued supply of young adults with tertiary education into Korea's workforce is therefore likely to lead to a continuation of the rising grey line and grey share of tertiary workers in the following figures.

[86] OECD (2019), "Education at a glance: Educational attainment and labour-force status", Population with tertiary education (indicator) OECD Education Statistics (database) doi: 10.1787/0b8f90e9-en (Accessed on 12 July 2019)

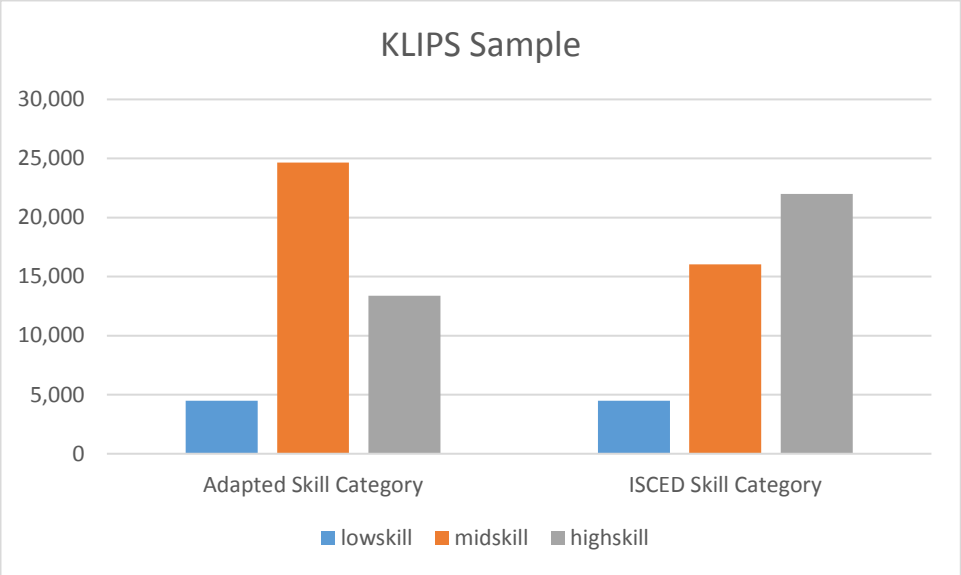
[87] OECD (2018:42), Education at a Glance 2018: OECD Indicators, OECD Publishing, Paris, Figure A1.1. Percentage of 25-34 year-olds without upper secondary education, by gender (2017)

FIGURE 3.1: KOREA'S ACADEMIC INFLATION



Source: Author's calculation using *The Economically Active Population Survey*, Statistics Korea Database (통계청,「경제활동인구조사」)

FIGURE 3.2: ALTERNATIVE SKILL CATEGORIES



Source: Author's calculation using *KLIPS*

The KLIPS sample used in this study also shows a similar pattern to the official statistics, with a total of 10.54% of low-skilled, 37.72% medium skilled, and 51.74% high-skilled worker-year observations when following ISCED. In other words, allocating workers according to ISCED makes more than half of the workers in the sample to be categorized as "high-skilled," inflating the proportion of high skilled workers in Korea with respect to medium skilled workers. This is because of some particular characteristics of Korea's labor market: graduates from 2-year technical colleges in Korea are usually not considered by overall Korean sentiment to be "high skilled" workers. In fact, even 4-year university graduates have become so abundant that there is evidence of further differentiation between top elite universities versus relatively unknown universities in the labor market (Ko 2011). The rising relative demand for and wage premium on elite

university graduates in Korea may reflect the fact that firms and employers do not see all 4 year university graduates to be the "high-skilled" employees they are looking for. Indeed, it is also shown in the robustness checks[88] later on in this study that if ISCED standards are used, the skill-biased effect favoring high-skilled workers effectively seems to disappear, as workers who would be considered to be medium-skilled in Korea's labor market are grouped together with actual high-skilled workers, putting downward pressure on the estimates of high-skilled labors' wages. It therefore seems highly justifiable to use an alternative skill classification different from international standards, if the goal is to examine heterogeneous effects on labor market outcomes depending on the relative skill category of workers.

3.3 Constructing GVC Trade Variables from OECD TiVA

TiVA provides a collection of GVC trade measures derived from the OECD Inter-Country Input-Output (ICIO) database[89], which can be used directly for empirical research. However, the main three GVC participation indices of interest in this study (as well as the fourth alternative specification) must be manually calculated using the available principle indicators, because industry-level GVC participation measures are not directly accessible. For example, as of July 2019, the TiVA indicator that is explicitly denoted as "forward participation in GVCs"[90] provides aggregate estimates of Korea's

[88] This is to examine the results in a way that allows easier international comparability

[89] https://stats.oecd.org/Index.aspx?DataSetCode=TIVA_2018_C1

[90] OECD Stat states that "the indicator estimates the VA contents of exports originated in the source

forward linkages in GVCs, but it does not provide each separate industry's forward participation rate. The same problem can be seen for the backward participation measure. In this research, Korea's backward participation in each industry is thus calculated by dividing the foreign value-added embodied in the exports of a domestic industry in Korea to the world, divided by gross exports to the world. The sell-side measure of forward linkage participation in GVCs is calculated by first looking at the "origin of value added in gross exports," which the TiVA database explains as revealing "how the value of a country's gross exports of intermediate and final products is an accumulation of value generated by many industries in many countries." Korea is set as the source country of origin, and all the values are added for each source industry where the value added is generated, for each exporting country's industries in all countries in the dataset, and then finally divided by the sum gross exports from Korea in these industries.[91] The total GVC participation index is then easily calculated by summing the forward and backward indices for each respective industry in each year. The result is a data set of three GVC participation indices spanning the years 2005-2015 in the 36 industries provided in the most recent 2018 update of the TiVA database. They are expressed shares of total exports in decimals.

country, and embodied in the exports of the exporting country, divided by the gross exports of the source country" (Last accessed July 2019)

[91] The author expresses gratitude to Sébastien Miroudot of the OECD Trade and Agriculture Directorate for his assistance in constructing the forward and backward participation variables

3.4 Alternative GVC Measures for Robustness Checks

Similar to the approach of Geishecker, Görg and Munch (2010), who used a lagged value of outsourcing to address any remaining endogeneity issues, this study uses time lags of GVC participation measures in the first stage of robustness checks. 1 year and 2 year lagged variables are thus constructed for all three GVC participation variables. For usage in a second round of robustness checks, the Value Added Export (VAX) ratio is constructed from the TiVA database by using the domestic value added embodied in foreign final demand and dividing it by gross exports, for each industry of Korea. 1 year and 2 year lagged versions of the VAX ratio are then subsequently built from the original variable. Thus, including the lagged variables, a total of 12 GVC participation measures for 36 industries are used as the main GVC-trade independent variable in the econometric estimations. It should be noted that when lagged variables are used, extra years are included, leading to more individual-year observations used for estimation. To illustrate, since KLIPS data is available from 2009 to 2017, and TiVA 2005-2015, the original regressions estimate observations in KLIPS from 2009 to only 2015. However, when a one-year lagged value is used for GVC participation, individuals in KLIPS (2009-2016) are matched with TiVA data from 2008 to 2015, and two year lags allow estimation of KLIPS (2009-2017) with TiVA (2007-2015). This adds one or two more years of observations.

TABLE 3.2: SUMMARY OF KEY VARIABLES

	Name	Definition / Description	Source	Period
Dependent Variable	Log Monthly Wages	Natural logarithm taken on average monthly wages of individual wage earners	KLIPS	2009-2017
Main Independent Variables	Total GVC Participation	Sum of Forward and Backward Participation	OECD TiVA	2005-2015
	Forward Participation	Exported Domestic VA to third countries (VS1 Share)	OECD TiVA	2005-2015
	Backward Participation	Imported Foreign VA share of Gross Exports (VS Share)	OECD TiVA	2005-2015
	Skill Level of Workers	Low: Middle school graduates or lower (Base category)	KLIPS	2009-2017
		Medium: 2-year colleges and high school diplomas		
		High: 4-year university degrees and above		
Alternative Specification (Robustness Checks)	VAX Ratio	Value Added Export Ratio (Domestic VA embodied in Foreign Final Demand / Gross Exports)	OECD TiVA	2005-2015
	Time Lagged GVC Variables	One and Two Year Lagged Total, Forward, Backward GVC Indices and VAX Ratio	OECD TiVA	2006-2016 2007-2017

Note: *Control variables are not included in the table due to their large number*

3.5 Matching GVC Industries with KLIPS

Data from KLIPS are in the Korean Standard Industrial Classification (KSIC), which can be roughly matched with OECD TiVA data that follows the United Nations Statistical Division (UNSD) International Standard Industrial Classification of All Economic Activities (ISIC) and. Industry data in KLIPS are classified according to either the KSIC 8th Revision (2000), or the KSIC 9th Revision (2007), while OECD TiVA is based on ISIC Rev.4 that was adopted in 2006 and published in 2007. The 2007 KSIC Rev.9 is better suited for matching with the 2008 ISIC Rev.4 compared to the 2000 KSIC Rev.8, but it has more missing values. When KLIPS observations are restricted to the 2009 consolidated sample, the difference in the number of missing values is negligible, but to use the original KLIPS sample starting from 1998, it is only possible to use KSIC Rev.8 (2000) to avoid losing most of the observations. Since this research only examines the years 2009 and beyond, and for these years the number of missing values is small, KSIC Rev.9 is chosen and matched with ISIC Rev.4, since these newer classifications better represent contemporary innovations in technology or new industries such as service activities.[92][93]

KLIPS industry data is at the 3-digit level while the GVC indicators are at the

[92] UNSD (2008) *International Standard Industrial Classification of All Economic Activities, Revision 4*, Statistical Papers, ST/ESA/STAT/Series M No.4/Rev.4 (https://unstats.un.org/unsd/publication/seriesM/seriesm_4rev4e.pdf)

[93] What's New? Differences between the 2018 and 2016 editions of TiVA indicators (Draft, December 2018) (http://www.oecd.org/industry/ind/tiva-2018-differences-tiva-2016.pdf)

2 digit level. Unfortunately, some compromises must still be made as a small number of the 3-digit Korean industry sub-categories do not perfectly match the 2 digit OECD data. For example, while most of the industries in KLIPS 101-120 fit well into OECD 10T12 (Manufacturing of food products, beverages, tobacco), KSIC 56191 (a small sub-category of KLIPS 561) is also supposed to be part of 10T12. However, most other categories of KSIC 56111~56199 correspond rather to OECD 55T56 (Accommodation and food services). Since there is no way to tell which of these OECD categories corresponds to the 3-digit 561 industry code of the KLIPS observations, all KLIPS observations with industry code 561 are put into OECD 55T56. Likewise, although most subcategories of KLIPS 261~274 would overall correspond to OECD 26 (Computer, electronic and optical products), some of the subcategories of 271 should correspond to 31T33, while KSIC 33402 and 10798 are divided into products that fit into either 31T33 & 26 or 55T56 & 10. Such discrepancies are ignored, with all KLIPS industry codes from 261-274 designated to OECD 26, all KSIC observations corresponding to industry code 334 matched with 31T33 and KSIC 107 into OECD 10 rather than 55T56. There are many other such sub-categories that must be compromised, but the number of such inconsistent sub-categories are few enough to be negligible on the empirical results. A summary table which shows how the industries were matched is presented on the following page

TABLE 3.3: MATCHED INDUSTRY CATEGORIES OF TIVA AND KLIPS

Industry Categories	OECD ISIC Rev.4 (2006)	KLIPS KSIC Rev. 9 (2007)
Agriculture, forestry, and fishing	01T03	11~32
Mining & extraction of energy producing products	05T06	51~52
Mining & quarrying of non-energy producing products	07T08	61~72
Mining support service activities	09	80
Food products, beverages, tobacco	10T12	101~120
Textiles, wearing apparel, leather and related products	13T15	131~152
Wood and products of wood and cork	16	161~163
Paper products and printing	17T18	171~182
Coke and refined petroleum products	19	191~192
Chemicals and pharmaceutical products	20T21	201~213
Rubber and plastic products	22	221~222
Other non-metallic mineral products	23	231~239
Basic metals	24	241~243
Fabricated metal products	25	251~259
Computer, electronic and optical products	26	261~270 / 272~274
Electrical machinery and apparatus, nec	27	281~289
Machinery and equipment, nec	28	291~292
Motor vehicles, trailers and semi-trailers	29	301~303
Other transport equipment	30	311~319
Other manufacturing; repair and installation of machinery and equipment	31T33	271, 320~339, 951
Electricity, gas, water supply, sewerage, waste and remediation services	35T39	351~390
Construction	41T43	411~425
Wholesale and retail trade, repair of motor vehicles	45T47	451~479; 952
Transportation and storage	49T53	491~529; 611
Accommodation and food services	55T56	551~562
Publishing, audiovisual and broadcasting activities	58T60	581~602
Telecommunications	61	612
IT and other information services	62T63	620~639
Financial and insurance services	64T66	641~662
Real estate activities	68	681~682
Other business sector services	69T82	691~759
Public admin. and defense, compulsory social security	84	841~845
Education	85	851~857
Human health and social work	86T88	861~872
Arts, entertainment recreation and other service activities	90T96	901~949; 953~969
Private households with employed persons	97T98	970, 981, 982

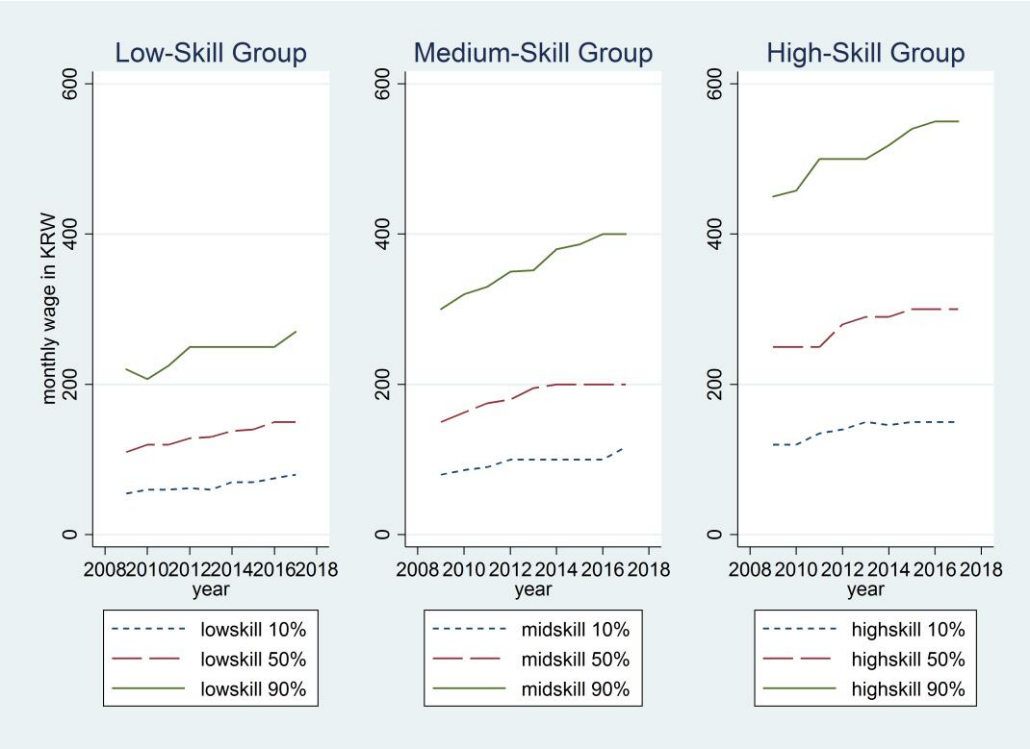
IV. RESULTS & INTERPRETATION

1. Main Specification

This section presents the regression results for the main specification on total GVC participation and follows with the regression output for forward and backward GVC participation. Before interpreting the signs and significance of the coefficients, it should be noted that the dependent variable (log of average monthly wages) is expressed in nominal Korean won. In the regressions, the intercept is allowed to differ across years by including time dummies, in order to control for changes in prices such as those due to inflation. As mentioned in chapter three[94], these time fixed effects also control for economy-wide changes in business cycles or technological progress. The initial model includes a limited number of control variables since too many fixed effects and control dummies would use up many degrees of freedom and variation of the variables may become too small to estimate the effects of the independent variables with precision. In particular, the variation of GVC participation at the industry level is expected to be reduced considerably with the inclusion of controls for firm size, region and occupation.

[94] Please consult the section for details on the baseline panel regression equation as well as dependent, independent, and control variable construction

TABLE 4.1: WAGES BY SKILL CATEGORY



Source: Author's calculations based on refined KLIPS sample

Before interpreting the regression results, a quick scan of the average wage trend of the bottom 10th percentile, median and 90th percentile of low, medium, and high-skilled workers suggests that wages of high-skilled workers in particular have increased faster than low-skilled workers. The regression results will now focus on whether high-skilled workers see magnified boosts to their wages compared to lower-skilled labor as sector-level GVC participation increases, controlling for all other variables.

Interpretation of Regression on Total GVC Participation

TABLE 4.2 FIXED-EFFECTS LOG WAGE REGRESSION ON TOTAL GVC PARTICIPATION

VARIABLES	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4	(5) Model 5	(6) Model 6	(7) Model 7	(8) Model 8
age	0.047***	0.047***	0.044***	0.044***	0.044***	0.043***		
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)		
agesq	-0.001***	-0.001***	-0.001***	-0.001***	-0.000***	-0.000***	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
tenure	0.030***	0.030***	0.023***	0.024***	0.023***	0.023***	0.005***	0.005***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
tenuresq	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
union	0.131***	0.133***	0.072***	0.073***	0.076***	0.077***	0.008	0.008
	(0.012)	(0.012)	(0.013)	(0.013)	(0.013)	(0.013)	(0.009)	(0.009)
1.male	0.388***	0.387***	0.410***	0.409***	0.409***	0.409***		
	(0.009)	(0.009)	(0.010)	(0.010)	(0.010)	(0.010)		
1.permregular	0.394***	0.395***	0.304***	0.305***	0.306***	0.306***	0.198***	0.197***
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.013)	(0.013)
2.edu_ midskill	0.189***	0.190***	0.116***	0.107***	0.116***	0.107***	-0.516***	-0.519***
	(0.018)	(0.019)	(0.017)	(0.019)	(0.017)	(0.019)	(0.022)	(0.028)
3.edu_ highskill	0.450***	0.441***	0.269***	0.255***	0.268***	0.255***	-0.246***	-0.253***
	(0.020)	(0.022)	(0.020)	(0.022)	(0.020)	(0.022)	(0.059)	(0.061)
Total GVC Participation	0.809***		0.491***		0.460***		0.639***	
	(0.150)		(0.135)		(0.135)		(0.216)	
edu_lowskill(base)#c.total		0.594		-0.285		-0.334		0.192
		(0.693)		(0.612)		(0.619)		(0.756)
edu_midskill#c.total		0.567***		0.439***		0.407**		0.590**
		(0.185)		(0.167)		(0.167)		(0.253)
edu_highskill#c.total		1.270***		0.684***		0.657***		0.855**
		(0.265)		(0.232)		(0.227)		(0.430)
1.married			0.061***	0.061***	0.061***	0.061***	-0.010	-0.010
			(0.010)	(0.010)	(0.010)	(0.010)	(0.013)	(0.013)
2.firmsize			0.101***	0.102***	0.100***	0.100***	0.033***	0.033***
			(0.011)	(0.011)	(0.011)	(0.011)	(0.007)	(0.007)
3.firmsize			0.233***	0.232***	0.228***	0.228***	0.052***	0.052***
			(0.011)	(0.011)	(0.011)	(0.011)	(0.008)	(0.008)
Constant	3.307***	3.311***	3.460***	3.471***	3.474***	3.485***	6.732***	6.738***
	(0.068)	(0.069)	(0.071)	(0.071)	(0.071)	(0.072)	(0.105)	(0.106)
Number of Clusters	7,689	7,689	7,077	7,077	7,077	7,077	5,574	5,574
Observations	31,974	31,974	27,015	27,015	27,015	27,015	25,512	25,512
Year FE	YES	YES	YES	YES	YES	YES	YES	YES
Region Dummies	NO	NO	NO	NO	YES	YES	YES	YES
Occupation Dummies	NO	NO	YES	YES	YES	YES	YES	YES
Individual FE	NO	NO	NO	NO	NO	NO	YES	YES
SE of regression	0.406	0.406	0.380	0.380	0.379	0.379	0.210	0.210
Adjusted R-Squared	0.552	0.552	0.591	0.591	0.594	0.594	0.870	0.870

Notes:
(i) FE short for fixed effects
(ii) Cluster-robust standard errors in parentheses
(iii) *** p<0.01, ** p<0.05, * p<0.1
(iv) Re-parameterized interaction effects

1.1. Total GVC Participation

An examination of the control variables in the semi-log wage equation in Table 4.2 shows that being a union member, male, or permanent/regular worker all have highly significant and positive impacts on wages. For instance, in model 1, the average wage rate of a union member is higher by approximately 13.1%[95] compared to the average wage rate of non-union members, holding all other variables constant. Furthermore, as expected, the coefficients for control variables age, age squared, job tenure, and tenure squared are all highly significant, with age and tenure having positive values but age squared and tenure squared showing negative values. This reflects how the growth rate of wages are positive depending on age and tenure, but probably at a decreasing rate. A simple calculation on the total sample before regression showed that on average, wages increase until workers become around 42 years old. Furthermore, the regression output shows clear positive and significant effects for higher educational attainment, as well as being married or working in a larger firm.

More important is the effect of the main independent variable of interest, total GVC participation. Model 1, which does not allow for different slopes of GVC participation depending on educational attainment, presents the main effect of total GVC participation. When total GVC participation increases by *one unit*, average monthly wages increase by approximately 80.9%, all other variables being equal. Moreover, as can be seen in the other models without interaction effects (Models 3, 5, and 7), the effect of total GVC participation remains highly significant and positive at the 1% level (although less in magnitude) even after including additional control

[95] Since the dependent variable is logged, the more accurate calculation would be to take the natural exponential or antilog of the coefficient to the base e and subtracting 1, leading to about 13.997%, but this research interprets coefficients based on the simpler approximation method

variables such as dummies for marriage, firm size, occupation, and region, as well as individual fixed effects that control for unobserved heterogeneity among individuals.[96] For example, a 0.01 unit[97] increase in total GVC participation increases average monthly wages by about 4.6% in Model 5, *ceteris paribus*. The reduced magnitude of the coefficient suggests that some of the positive effect of GVC participation on wages operates through the newly introduced control variables – for example, it is well known that Korean *chaebols* such as Samsung, Hyundai or LG are among the most integrated in GVCs. Moreover, their factories and production sites are concentrated in certain regions and industrial complexes, and there may also exist a tendency for individuals working in highly GVC integrated industries to be specialized in certain occupations. Dollar (2017:164) mentioned the considerable heterogeneity existing at the regional level in infrastructure such as transport, legal and financial institutions, and human capital as well as labor force characteristics such as skills and wage levels which can influence the degree of GVC participation. Since the effect of GVC participation would partially work through these control variables, it is normal for the magnitude to decrease. Despite the variation to have likely been partialed out through the control variables, the findings of a significant positive effect of industry-level total GVC participation on average monthly wages of individual workers remains robust,

[96] It should be noted that with this data and empirical model, including individual fixed effects is likely to have many problems. For instance, out of 8,582 individuals, only 177 have a different education level over time, which is not enough to have a proper estimation of the education variable in a specification with individual fixed effects.

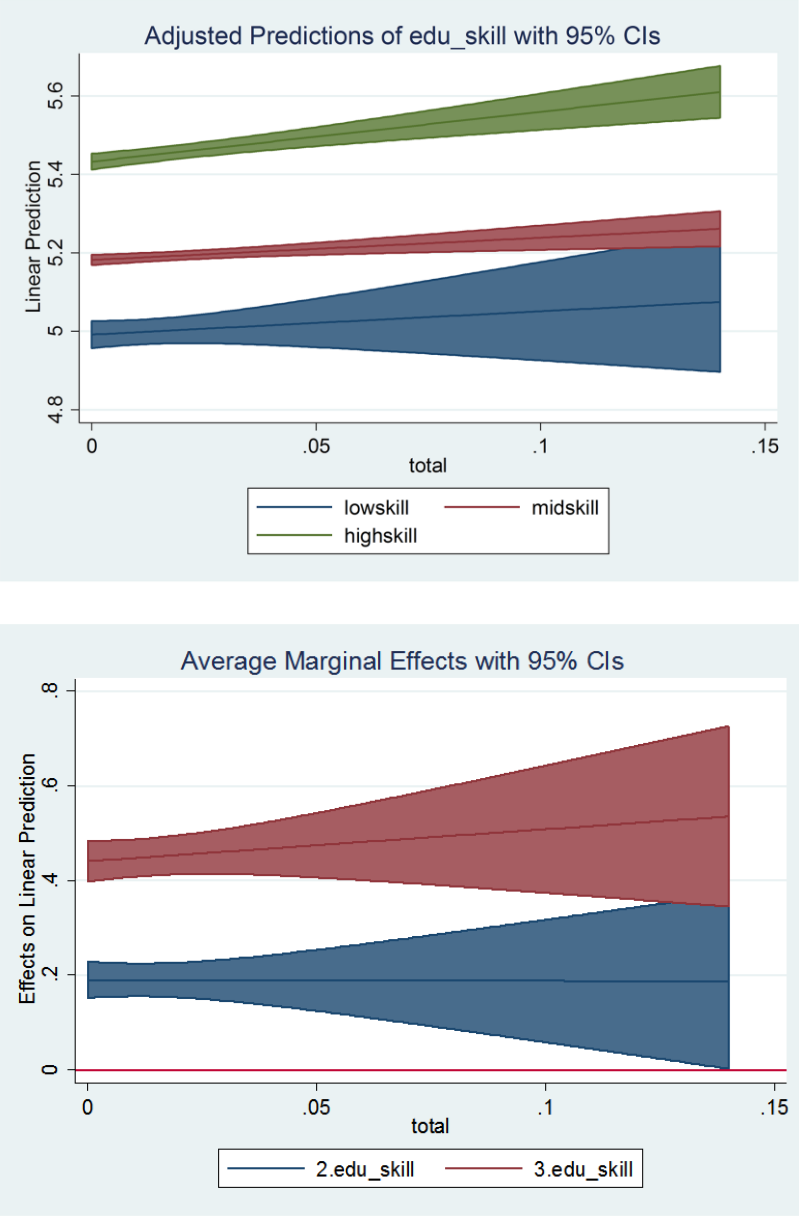
[97] GVC participation is highly unlikely to suddenly change by a whole unit, as it is a share of exports, expressed in decimals. Therefore, for more realistic interpretation, the interpretations henceforth refer to 0.01 unit or 1% changes in the GVC variable as opposed to a 1 unit change

supporting *hypothesis 1b*. At the micro level, even if total GVC trade includes higher amounts of foreign value added in exports (Korea has a very high foreign import content), there are clear positive overall effects on wages.

Models 2, 4, 6, and 8 introduce product terms to allow the coefficients of GVC participation to differ depending on education level. The interaction effects are re-parameterized to directly show the magnitude and direction of the estimated slopes of GVC participation on wages for workers in each skill category, as well as showing significance tests akin to calculating marginal effects or post-estimation linear combination tests of the interaction. The baseline model with the interaction effect included is Model 2. The interaction coefficients for total GVC participation of mid-skilled and high-skilled workers are highly significant. Most importantly, high skilled workers working in industries with higher GVC participation levels earn a much higher boost to their wages compared to low or mid skilled workers. In the baseline model, a 1% increase in GVC participation is associated with approximately 1.27% higher wages for high skilled workers, while medium skilled workers gain only a 0.57% boost to wages. Although the results show that the coefficients of mid and high-skilled labor are significantly different from zero, the coefficient of the base category, low-skilled workers, cannot be estimated with sufficient precision. This may partly be due to the fact that the sample size for low-skilled workers is considerably smaller.. Nevertheless, the much stronger positive effect of total GVC participation on high skilled workers as compared to medium-skilled or low-skilled labor shows evidence of a *skill bias*.

As mentioned earlier, the baseline panel regression models 1 and 2 may better show how variation in GVC participation may work through other channels or independent variables. Including firm size further reduces accurate estimation in the case of KLIPS, as it is one of the few variables in this study that has a relatively high proportion of missing values. Likewise, the initial model does not include regional dummies or occupational dummies because including fixed-effects by occupation or region might be too much for the model. The geographic region that each individual inhabits is likely to be highly correlated with GVC participation. Many industries are concentrated in huge industrial complexes located in specific regions which also participate the most heavily in GVCs. Examples include LCD clusters in Chungcheong Province (Lee *et al.* 2014) as well as shipbuilding, auto manufacturing, and steel companies near Ulsan. In this case, regional dummies may absorb part of the GVC participation, reducing the magnitude and/or significance of coefficients. Likewise, occupations can be another measure of workers' skills and overlap to some degree with education. Dummies for these variables were therefore included later in the analysis. Nevertheless, the skill-biased results do not change substantially when including the occupation dummies. The coefficient of the interaction term for high-skilled workers continues to be statistically significant at the 1% level (except when individual fixed effects are included in Model 8, when it becomes significant at the 5% level), and is greater than that for low or medium-skilled workers. Although the inclusion of more control variables and fixed effects may partial out the effect of GVC participation, the findings of a significant skill-biased effect remain robust in all the remaining models.

FIGURE 4.1 MARGINS PLOTS FOR
TOTAL GVC PARTICIPATION



Notes: Calculation based on baseline panel regression on total GVC participation

The upper graph in **Figure 4.1** depicts the marginal effect of total GVC participation as it moves from 0 to 0.14, for workers in low, medium, and high skill categories. In other words, the graph plots the impact of GVC participation on the fitted value of wages when all other control variables are kept constant at their sample means. This margins plot is based on the initial baseline Model 2. The slope for high skilled workers seems to grow at a faster rate than the other groups. Meanwhile, the lower graph shows where the difference in values for mid skilled and high skilled labor is statistically significant from the base or reference group (low skilled workers). The blue block of results compares low skilled with mid skilled and is significant for most total GVC participation values between 0 and 0.15. The red shaded area comparing low skilled with high skilled is significant for all total GVC participation values. These graphical illustrations of the regressions thus support an intuitive understanding of how global supply chain trade is skill-biased for Korean workers at the micro level. The boost in wages caused by deeper GVC integration at the industry level is clearly larger for high skilled workers than workers with lower levels of educational attainment, supporting hypothesis 1c. *To sum, high-skilled workers employed in industries with higher GVC participation receive a greater boost to their wages than workers with lower levels of educational attainment.* ***Hypothesis 1c*** *expecting a skill bias of GVC participation is* ***supported****.*

Interpretation of Regression on Forward GVC Participation

TABLE 4.3 FIXED-EFFECTS LOG WAGE REGRESSION ON FORWARD GVC PARTICIPATION

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
age	0.047***	0.047***	0.044***	0.044***	0.043***	0.043***		
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)		
agesq	-0.001***	-0.001***	-0.001***	-0.001***	-0.000***	-0.000***	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
tenure	0.030***	0.030***	0.023***	0.024***	0.023***	0.023***	0.005***	0.005***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
tenuresq	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
union	0.134***	0.136***	0.072***	0.074***	0.076***	0.077***	0.008	0.008
	(0.012)	(0.012)	(0.013)	(0.013)	(0.013)	(0.013)	(0.009)	(0.009)
1.male	0.391***	0.389***	0.411***	0.410***	0.410***	0.409***		
	(0.009)	(0.009)	(0.010)	(0.010)	(0.010)	(0.010)		
1.permregular	0.397***	0.398***	0.305***	0.306***	0.306***	0.307***	0.198***	0.198***
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.013)	(0.013)
2.edu_midskill	0.188***	0.186***	0.116***	0.101***	0.116***	0.100***	-0.505***	-0.529***
	(0.018)	(0.020)	(0.017)	(0.019)	(0.017)	(0.019)	(0.021)	(0.034)
3.edu_highskill	0.448***	0.424***	0.268***	0.235***	0.268***	0.234***	-0.234***	-0.263***
	(0.020)	(0.023)	(0.020)	(0.023)	(0.020)	(0.023)	(0.059)	(0.063)
Forward GVC Participation	1.257***		0.674*		0.609		1.222**	
	(0.419)		(0.405)		(0.407)		(0.605)	
edu_lowskill(base)#c.forward		-0.750		-3.184*		-3.397**		-1.350
		(1.791)		(1.700)		(1.699)		(1.821)
edu_midskill #c.forward		0.316		0.067		0.024		1.181
		(0.506)		(0.493)		(0.496)		(0.733)
edu_highskill#c.forward		3.516***		2.403***		2.327***		1.921*
		(0.778)		(0.711)		(0.700)		(1.114)
1.married			0.061***	0.061***	0.061***	0.060***	-0.010	-0.010
			(0.010)	(0.010)	(0.010)	(0.010)	(0.013)	(0.013)
2.firmsize			0.104***	0.104***	0.103***	0.103***	0.034***	0.034***
			(0.011)	(0.011)	(0.011)	(0.011)	(0.007)	(0.007)
3.firmsize			0.235***	0.234***	0.231***	0.230***	0.053***	0.053***
			(0.011)	(0.011)	(0.011)	(0.011)	(0.008)	(0.008)
Constant	3.309***	3.322***	3.464***	3.487***	3.478***	3.501***	6.723***	6.746***
	(0.068)	(0.069)	(0.071)	(0.072)	(0.071)	(0.072)	(0.105)	(0.106)
Number of Clusters	7,689	7,689	7,077	7,077	7,077	7,077	5,574	5,574
Observations	31,974	31,974	27,015	27,015	27,015	27,015	25,512	25,512
Year FE	YES	YES	YES	YES	YES	YES	YES	YES
Region Dummies	NO	NO	NO	NO	YES	YES	YES	YES
Occupation Dummies	NO	NO	YES	YES	YES	YES	YES	YES
Individual FE	NO	NO	NO	NO	NO	NO	YES	YES
SE of regression	0.406	0.406	0.380	0.380	0.379	0.379	0.210	0.210
Adj. R-Squared	0.551	0.551	0.590	0.591	0.594	0.594	0.870	0.870

Notes:
(i) FE short for fixed effects
(ii) Cluster-robust standard errors in parentheses
(iii) *** p<0.01, ** p<0.05, * p<0.1
(iv) Re-parameterized interaction effects

1.2. Forward GVC Participation

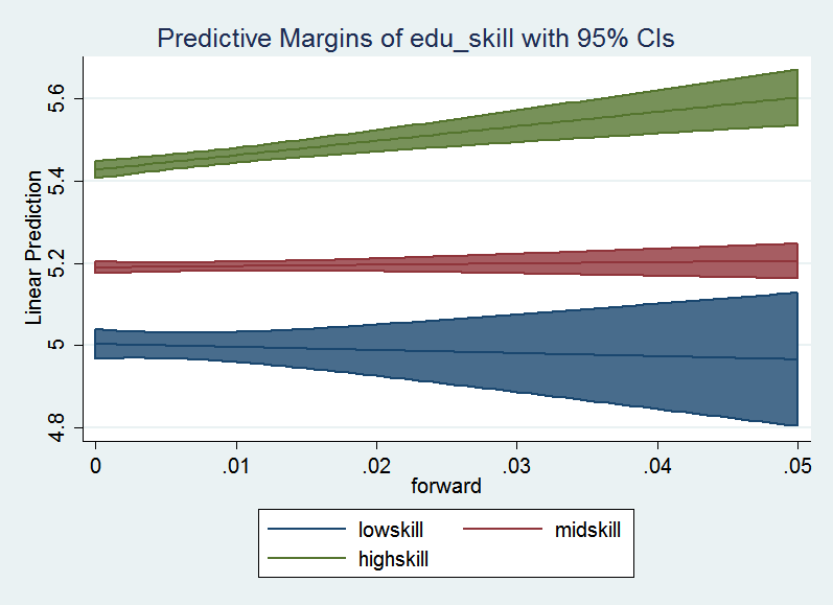
One of the important contributions of this research compared to existing studies[98] on the micro-level effect of GVC trade on wages in Korea is that the three different types of GVC participation are distinguished. Based on the qualitative characteristics of Korea's backward and forward supply chain trade, this thesis hypothesized that deeper forward GVC linkages at the industry level are most likely to show strong skill-biased effects, in contrast with the cross-country empirical findings of Farole *et al.* (2018). In other words, the domestic value added of Korea embodied in intermediate input exports assembled and re-exported to third economies is likely to contribute to a very high boost to wages of high-skilled workers in comparison with low or medium-skilled workers. The panel regression output for all model specifications strongly support ***hypothesis 2b*** that forward GVC Participation would show the most *extreme* skill-bias among all three types of GVC participation.

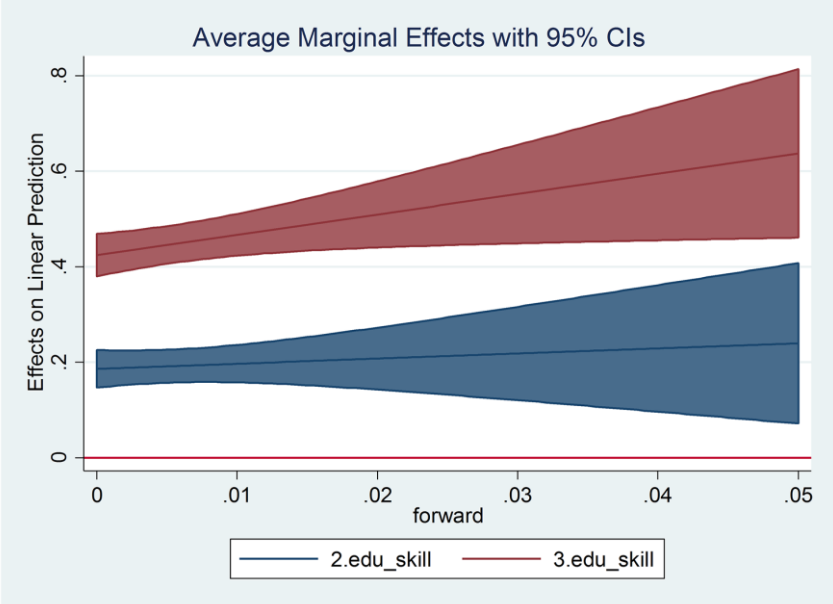
An omnibus Wald test on the overall interaction of skills by forward GVC participation in wages for the baseline model 2 had a p-value of 0.0015, rejecting the null hypothesis that medium and high skilled workers' coefficients are both zero at the 1% level. This global two degree of freedom test suggests that there is a statistically significant interaction (Jaccard and Turrisi, 2003:86). Now looking directly at the product terms in the regression table, low skilled workers receive a significant *negative* impact in models

[98] To the best of the author's knowledge, among micro-level studies, there is only Choi *et al.*(2015), published in Korean

4 and 6, with a 1% increase in forward participation corresponding to about 3.2% or 3.4% reductions in wages. For medium-skilled workers, there is a non-significant weakly positive coefficient, suggesting that the positive productivity and negative substituting forces associated with GVC trade and offshoring offset each other. On the other hand, high skilled workers working in industries with higher forward participation levels earn a much higher boost to their wages compared to low or mid skilled workers. For instance, in baseline model 2, an increase of forward GVC trade by 0.01 units results in a substantial 3.5% increase in high-skilled workers wages, and other specifications also show wage boosts of at least 1.9% for high-skilled workers. All of the coefficients are considerably higher than the corresponding slopes for total participation.

FIGURE 4.2 MARGINS PLOTS FOR
FORWARD GVC PARTICIPATION





Notes: Calculation based on baseline panel regression on total GVC participation

Figure 4.2 portrays the marginal effect of forward GVC participation as it moves from 0 to 0.5, for workers in low, medium, and high skill categories. Again, when all other control variables are kept constant at their sample means, the slope for high skilled workers seems to grow at a particularly faster rate than the other groups. In fact, low-skilled workers show evidence of slightly declining wages as domestic value added embodied in foreign exports to third countries increases. Although the graph shows that the difference in values between low and medium-skilled workers becomes less clear as forward GVC participation rises, the divergence between high skilled workers and other skill categories continues even as the confidence interval widens with increased forward supply chain trade.

In short, the skill-biased effect of forward GVC participation is strongest among all three types of GVC participation (the boost in wages caused by deeper forward linkages at the industry level is very large for high skilled workers compared to lower-skilled workers). ***Hypothesis 2b*** *is* ***supported****.*

Interpretation of Regression on Backward GVC Participation

TABLE 4.4 FIXED-EFFECTS LOG WAGE REGRESSION ON BACKWARD GVC PARTICIPATION

VARIABLES	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4	(5) Model 5	(6) Model 6	(7) Model 7	(8) Model 8
age	0.047***	0.047***	0.044***	0.044***	0.044***	0.044***		
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)		
agesq	-0.001***	-0.001***	-0.001***	-0.001***	-0.000***	-0.000***	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
tenure	0.030***	0.030***	0.024***	0.024***	0.023***	0.023***	0.005***	0.005***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
tenuresq	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
union	0.129***	0.131***	0.072***	0.072***	0.076***	0.076***	0.008	0.008
	(0.012)	(0.012)	(0.013)	(0.013)	(0.013)	(0.013)	(0.009)	(0.009)
1.male	0.387***	0.386***	0.410***	0.410***	0.409***	0.409***		
	(0.009)	(0.009)	(0.010)	(0.010)	(0.010)	(0.010)		
1.permregular	0.393***	0.394***	0.304***	0.304***	0.306***	0.306***	0.198***	0.198***
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.013)	(0.013)
2.edu_ midskill	0.190***	0.193***	0.116***	0.111***	0.116***	0.112***	-0.515***	-0.513***
	(0.018)	(0.019)	(0.017)	(0.018)	(0.017)	(0.018)	(0.023)	(0.023)
3.edu_ highskill	0.452***	0.449***	0.269***	0.265***	0.268***	0.264***	-0.245***	-0.245***
	(0.020)	(0.021)	(0.020)	(0.022)	(0.020)	(0.022)	(0.060)	(0.060)
Backward GVC Participation	1.288***		0.814***		0.770***		0.965***	
	(0.213)		(0.191)		(0.190)		(0.301)	
edu_lowskill(base)##c.backward		1.385		0.312		0.277		0.726
		(1.008)		(0.881)		(0.893)		(1.118)
edu_midskill #c.backward		1.044***		0.868***		0.816***		0.869**
		(0.262)		(0.237)		(0.238)		(0.345)
edu_highskill #c.backward		1.712***		0.799**		0.765**		1.244**
		(0.376)		(0.323)		(0.316)		(0.623)
1.married			0.061***	0.061***	0.061***	0.061***	-0.010	-0.010
			(0.010)	(0.010)	(0.010)	(0.010)	(0.013)	(0.013)
2.firmsize			0.100***	0.100***	0.099***	0.099***	0.033***	0.033***
			(0.011)	(0.011)	(0.011)	(0.011)	(0.007)	(0.007)
3.firmsize			0.232***	0.232***	0.227***	0.227***	0.053***	0.053***
			(0.011)	(0.011)	(0.011)	(0.011)	(0.008)	(0.008)
Constant	3.308***	3.309***	3.460***	3.464***	3.473***	3.477***	6.733***	6.733***
	(0.068)	(0.068)	(0.071)	(0.071)	(0.071)	(0.072)	(0.105)	(0.105)
Number of Clusters	7,689	7,689	7,077	7,077	7,077	7,077	5,574	5,574
Observations	31,974	31,974	27,015	27,015	27,015	27,015	25,512	25,512
Year FE	YES	YES	YES	YES	YES	YES	YES	YES
Region Dummies	NO	NO	NO	NO	YES	YES	YES	YES
Occupation Dummies	NO	NO	YES	YES	YES	YES	YES	YES
Individual FE	NO	NO	NO	NO	NO	NO	YES	YES
SE of regression	0.406	0.405	0.380	0.380	0.379	0.379	0.210	0.210
Adj. R-Squared	0.552	0.552	0.591	0.591	0.594	0.594	0.870	0.870

Notes:
(i) FE short for fixed effects
(ii) Cluster-robust standard errors in parentheses
(iii) *** p<0.01, ** p<0.05, * p<0.1
(iv) Re-parameterized interaction effects

1.3. Backward GVC Participation

Backward participation has a strongly positive and highly significant impact on wages at the 1% level when workers of all skill groups are assumed to have the same slope. In the baseline specification model 1, a 0.01 unit increase in backward GVC participation increases wages by approximately 1.3%. Although some variation is partialed out, the direction, magnitude, and significance of backward supply chain trade in boosting workers' wages remains robust to alternative specification with more controls in Model 3, 5, and 7. Imports of foreign intermediate inputs clearly seem to contribute to boosting wages of workers in Korea, although the data here does not clearly distinguish whether they are imports of primary raw material or energy products, sophisticated high-tech inputs, or low-skill-intensive simple inputs. Hypothesis 2a was based on the idea that since Korea's backward supply chain trade embodies these largely heterogenous and offsetting types of trade, there would be only a weak skill-biased impact on wages.

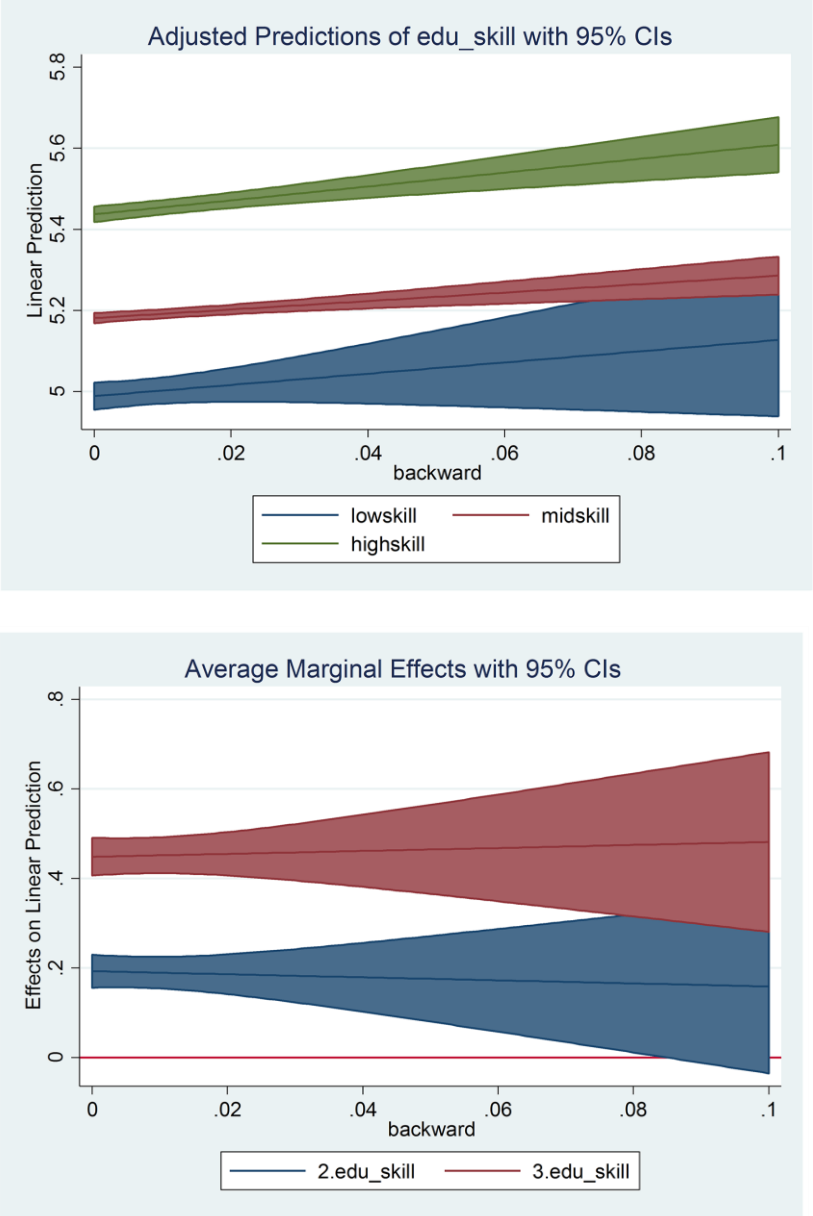
As shown in the regression results, for backward GVC participation, there is not much evidence of a skill-biased effect when allowing interaction effects. High-skilled workers working in industries with more foreign value added in exports do not necessarily get additional boosts to their wages compared to low or mid skilled workers. In fact, depending on the model, backward participation sometimes shows bigger positive impacts for mid-skilled workers compared to high-skilled labor. For instance, in model 6, where controls for firm size, region dummies, and occupation dummies are added, a 1% increase in imported foreign intermediate goods and services at the industry

level boosts medium-skilled labors' wages by about 0.82%, while high-skilled workers' wages increase by about 0.77%. The boost to wages of medium and high-skilled workers are thus similar in comparison with total and forward GVC participation, although there is some evidence of a skill bias if the considerably smaller boost to low-skilled workers are acknowledged. However, as in most of the previous regression output, low-skilled workers' coefficients cannot be estimated with precision, perhaps due to the much smaller sample size.

Figure 4.3 illustrates the margins plot of foreign value added in gross exports as it moves from 0 to 0.1, for workers in low, medium, and high skill categories. This time, the slopes do not show clear differences. For Korea, backward supply chain trade clearly boosts overall wages of workers but does not seem to be particularly favoring high-skilled workers.

The lack of evidence of a skill bias for backward participation is in line with López-González *et al.* (2015) who found that countries with a higher degree of backward participation tend to have lower levels of wage inequality, but directly contrasts with Farole *et al.* (2018). ***Hypothesis 2a*** *stating that Korea's backward GVC participation would also boost productivity and thus overall wages but have the weakest skill-biased effect is thus partially supported.*

FIGURE 4.3 MARGINS PLOTS FOR
BACKWARD GVC PARTICIPATION



Notes: Calculation based on baseline panel regression on total GVC participation

2. Further Robustness Checks

This thesis has shown that even when additional control variables and fixed effects (which may absorb considerable variation in the core GVC trade coefficients) are added to the baseline model, the estimated interaction terms of education and GVC participation remained statistically significant and positive. The core regression explanatory variables have continued to exhibit a skill-biased effect in wages in most alternative specifications. To strengthen the structural validity of this research, further robustness checks will be employed through alternative specifications of variables as has become common in empirical social studies.[99] This section of this chapter utilizes the VAX ratio for manufacturing, as well as time lagged GVC participation variables to see whether the estimates of the GVC-skill product terms continue to exhibit significant estimates in the direction of a skill bias. Before the usage of alternative supply chain trade measures, regression output using the international standard or educational attainment for categorizing skills is provided to facilitate international comparability. This alternative skill category illustrates how using homogeneous independent variables for countries can lead to misleading results.

[99] Lu and White (2014) are among a group of researchers who have questioned or criticized this method of attempting to enhance structural validity, but this study nevertheless follows the convention in the empirical literature

TABLE 4.5 FIXED-EFFECTS LOG WAGE REGRESSION ON TOTAL GVC PARTICIPATION, ISCED DEFINITIONS

VARIABLES	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4	(5) Model 5	(6) Model 6
age	0.055***	0.055***	0.049***	0.049***	0.048***	0.048***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
agesq	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
tenure	0.030***	0.030***	0.023***	0.023***	0.022***	0.022***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
tenuresq	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
union	0.126***	0.126***	0.064***	0.063***	0.067***	0.067***
	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)
1.male	0.391***	0.391***	0.417***	0.418***	0.416***	0.417***
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
1.permregular	0.385***	0.384***	0.296***	0.296***	0.298***	0.298***
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
2.edu_isced	0.171***	0.169***	0.104***	0.092***	0.103***	0.091***
	(0.018)	(0.020)	(0.017)	(0.019)	(0.017)	(0.019)
3.edu_isced	0.403***	0.405***	0.225***	0.217***	0.226***	0.219***
	(0.020)	(0.021)	(0.019)	(0.021)	(0.019)	(0.021)
total	0.697***		0.465***		0.444***	
	(0.158)		(0.138)		(0.138)	
1b.edu_isced#c.total		0.674		-0.228		-0.242
		(0.696)		(0.612)		(0.621)
2.edu_isced#c.total		0.859***		0.671***		0.663***
		(0.255)		(0.228)		(0.229)
3.edu_isced#c.total		0.599***		0.407**		0.377**
		(0.211)		(0.174)		(0.173)
1.married			0.060***	0.059***	0.060***	0.060***
			(0.010)	(0.010)	(0.010)	(0.010)
2.firmsize			0.108***	0.108***	0.107***	0.107***
			(0.011)	(0.011)	(0.011)	(0.011)
3.firmsize			0.245***	0.245***	0.240***	0.241***
			(0.011)	(0.011)	(0.011)	(0.011)
Constant	3.105***	3.105***	3.337***	3.345***	3.348***	3.355***
	(0.069)	(0.069)	(0.072)	(0.072)	(0.072)	(0.072)
Number of clusters	7,689	7,689	7,077	7,077	7,077	7,077
Observations	31,974	31,974	27,015	27,015	27,015	27,015
Year FE	YES	YES	YES	YES	YES	YES
Region Dummies	NO	NO	NO	NO	YES	YES
Occupation Dummies	NO	NO	YES	YES	YES	YES
SE of regression	0.409	0.409	0.382	0.382	0.380	0.380
Adj. R-Squared	0.544	0.544	0.587	0.587	0.591	0.591

Notes:
(i) FE short for fixed effects
(ii) Cluster-robust standard errors in parentheses
(iii) *** p<0.01, ** p<0.05, * p<0.1
(iv) Re-parameterized interaction effects

2.1. International ISCED Definition of Skills

Educational attainment is potentially a better proxy for skills as compared to many traditional studies that crudely defined high skilled and low skilled workers as production (blue collar) and non-production (white collar) workers. However, education was re-classified in this study to deal with academic inflation and to preserve the homogeneity of the high-skilled category. One may question whether results change when using international standards. When using ISCED classifications to measure skills, the skill-biased impact of global supply chain trade seems to disappear. More participation in the international fragmentation of production shows a positive and highly significant impact on both medium and high-skilled workers, with medium-skilled workers receiving disproportionately higher boosts to their wages compared to high-skilled labor. As mentioned in chapter 3, using the ISCED classification allocated 2-year technical college graduates into high-skilled categories, which does not accurately reflect the unique characteristics of Korea's labor market. High-school and 2-year technical graduates often work more as production workers, while a 4-year university diploma is the minimum qualification for many high-skilled jobs. Literature on Korea's labor market showed evidence that even 4-year universities are increasingly showing stratification into prestigious and less well-known schools. These results thus confirm that the usage of ISCED skill definitions instead of the educational attainment categories used in this study would be problematic.

2.2. Robustness to Endogeneity and Simultaneous Equation Bias

One of the advantages of this study that differentiates it from much of the previous literature is that instead of testing the impact of industry-level GVC participation on aggregate industry-level measurements of average wages, the micro-wage data of each individual person surveyed in KLIPS is directly used. The key benefit is better ability to deal with endogeneity problems coming from simultaneity bias.

An often cited problem in studies combining industry-level measures of trade with industry-level measures of wages is the possibility of the independent and dependent variable each determining the other simultaneously. For example, a large firm with high productivity and export competitiveness may be more likely to participate in GVCs compared to small firms, while GVC participation may simultaneously improve firm-level productivity. These firms would then expand production and may hire more workers - leading to an overestimation of how much GVCs actually contribute to productivity and boosts in wages. Since GVC participation at the industry level can be seen as the aggregation of subsets of firms' exports and imports, the overall industry level composition of skills, wages, and employment could then at least partially determine the degree of GVC trade. One increasingly popular method of dealing with endogeneity issues and omitted variable bias is to use a 2SLS or two stage least squares (2SLS) estimator using instrumental variables. Unfortunately, it is difficult to conceive a valid instrumental variable for GVC participation.[100] However, the industry-level

[100] A valid variable such as Z_{it}, which simultaneously satisfies the *relevance condition* stating that the

GVC measures should overall be exogenous to micro data on *individual*-level wages, so the lack of an appropriate instrumental variable should not pose a significant problem. It is highly unlikely that an individual worker's wage can somehow determine the degree of GVC trade engaged by the firms (and industries) they are employed in. Furthermore, although identifying the direction of causality between the two measures may be more challenging when comparing industry-level measures, it should be safe to assume that if one is comparing sector-level estimates and individual-level measures as in this study, it is the industry level of GVC participation affecting individual workers' wages rather than individual workers' wages somehow affecting how much the industry participates in GVCs.

2.3. Individual Fixed Effects

In spite of this argument, there may be some remaining anxiety over potential endogeneity and simultaneity bias that in any case continues to exist. One source of concern is omitted variable bias. Although a wide range of explanatory variables are included to control for observable differences among individuals, there may still be some omitted variables that may somehow affect GVC participation, educational attainment, and wages simultaneously, a problem in most types of empirical social research. A typical advantage of panel or longitudinal data is the ability to control for unobserved

explanatory variable of interest X_{it} should be correlated with Z_{it}, $\mathrm{Cov}(X_{it}, Z_{it}) \neq 0$, as well as the *exclusion condition* $\mathrm{Cov}(Z_{it}, \varepsilon_{it}) = 0$, where the instrument should affect the dependent variable only through the independent variable of interest and not through the error terms

heterogeneity using fixed effects in the panel dimension. The inclusion of individual fixed effects in order to control for unobservable individual-level characteristics that do not change over time would eliminate the cross-sectional *between* variation *across* individuals and focus on the effect of changes *within* individuals over time. In this research, some specifications did include individual fixed effects to control for other unobserved heterogeneity but doing so is highly problematic due to the time-invariant nature of the main skill variable. Including individual fixed effects is likely to result in model mis-specification. This is because the education level of each individual is unlikely to have any variation over time, and individual fixed effects wipe out the effect of independent variables which are in the same dimension of the fixed effect and do not change over time (another example is gender). In other words, since the main independent variable of interest is educational attainment in this study, which is usually fixed overall at the individual level (except a few exceptions when some individuals gain extra educational credentials), it is highly likely that individual fixed effects would decrease variation in the model too much to estimate coefficients with proper precision. A scan of the data sample shows that out of 8,582 individuals, only 177 have changing education levels as time passes, meaning that the variable is de-facto time-invariant. In short, individual fixed effects wipe out all between-individual variation that stays constant over time, making it improbable to properly assess the impact of time-invariant variables such as education on wages. This is why I do not hold constant the average effects of each individual in the main specifications. Since fixed effects models are most likely undesirable in this situation, and the number of individuals are considerably higher

than the number of years, this study instead reports standard errors robust to serial correlation and heteroskedasticity among clusters in the panel dimension (individuals). Models with individual fixed effects (specifications 7 and 8) were still included for transparency, and nevertheless showed robust evidence of skill-biased impacts on high-skilled wages (interaction effects are still significant in the expected direction and magnitudes), but caution is necessary in interpreting the estimates of the coefficients in these particular models due to the aforementioned reasons. Although most of the models do not include individual fixed effects, the inclusion of many other individual control variables should reduce much of the between variation among individuals, similar to fixed effect models. In any case, even fixed effects estimators cannot fully control for endogeneity bias, particularly when there is correlation between the omitted variables and independent variable. The study design of linking individual wage data with industry-level GVC indicators, as well as the inclusion of many other controls and adjustment of standard errors should allow a reasonable degree of methodological robustness and ability to confidently infer evidence of a skill bias of GVC trade.

2.4. Alternative Specifications: Time-Lagged GVC Trade Variables

Geishecker, Görg, and Munch (2010:185) mentioned that even research designs linking industry trade data with individual level wages could have some endogeneity left if individual workers' wages comprise industry-level factors such as the outcome of collective bargaining. They thus used lagged outsourcing variables to mitigate any remaining endogeneity problems (*ibid.*). With this in mind, this thesis includes as a robustness check time lags for GVC participation in order to strengthen further confidence both in the causal direction of the variables as well as in the significance of regression estimates.

Lagged Total GVC Participation

TABLE 4.6 FIXED-EFFECTS LOG WAGE REGRESSION ON 1-YEAR LAGGED TOTAL GVC PARTICIPATION

VARIABLES	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4	(5) Model 5	(6) Model 6
age	0.048***	0.048***	0.045***	0.045***	0.044***	0.044***
	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)
agesq	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
tenure	0.030***	0.030***	0.023***	0.023***	0.022***	0.022***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
tenuresq	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
union	0.131***	0.133***	0.071***	0.072***	0.075***	0.076***
	(0.012)	(0.012)	(0.013)	(0.013)	(0.013)	(0.013)
1.male	0.386***	0.385***	0.407***	0.406***	0.406***	0.406***
	(0.009)	(0.009)	(0.010)	(0.010)	(0.010)	(0.010)
1.permregular	0.397***	0.398***	0.307***	0.308***	0.308***	0.309***
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
2.edu_midskill	0.186***	0.186***	0.117***	0.106***	0.117***	0.106***
	(0.017)	(0.019)	(0.017)	(0.019)	(0.017)	(0.019)
3.edu_highskill	0.443***	0.431***	0.267***	0.251***	0.266***	0.251***
	(0.020)	(0.021)	(0.020)	(0.022)	(0.020)	(0.022)
gvctotal_lag1	0.781***		0.477***		0.442***	
	(0.146)		(0.131)		(0.130)	
1b.edu_lowskill#c.gvctotal_lag1		0.352		-0.432		-0.467
		(0.672)		(0.595)		(0.602)
2.edu_midskill#c.gvctotal_lag1		0.531***		0.404**		0.368**
		(0.179)		(0.161)		(0.161)
3.edu_highskilli#c.gvctotal_lag1		1.282***		0.715***		0.683***
		(0.260)		(0.225)		(0.219)
1.married			0.060***	0.060***	0.059***	0.059***
			(0.010)	(0.010)	(0.010)	(0.010)
2.firmsize			0.107***	0.107***	0.106***	0.107***
			(0.011)	(0.011)	(0.010)	(0.010)
3.firmsize			0.233***	0.232***	0.229***	0.228***
			(0.010)	(0.010)	(0.010)	(0.010)
Constant	3.310***	3.316***	3.461***	3.474***	3.475***	3.488***
	(0.065)	(0.065)	(0.067)	(0.068)	(0.067)	(0.068)
Observations	36,672	36,672	30,973	30,973	30,973	30,973
R-squared	0.552	0.552	0.591	0.592	0.595	0.595
Year FE	YES	YES	YES	YES	YES	YES
Region Dummies	NO	NO	NO	NO	YES	YES
Occupation Dummies	NO	NO	YES	YES	YES	YES
Individual FE	NO	NO	NO	NO	NO	NO
SE of regression	0.405	0.405	0.380	0.380	0.378	0.378
Adj. R-Squared	0.552	0.552	0.591	0.591	0.594	0.595

Notes:
(i) FE short for fixed effects
(ii) Cluster-robust standard errors in parentheses
(iii) *** p<0.01, ** p<0.05, * p<0.1
(iv) Re-parameterized interaction effects

Lagged Forward GVC Participation

TABLE 4.7 FIXED-EFFECTS LOG WAGE REGRESSION ON 1-YEAR LAGGED FORWARD GVC PARTICIPATION

VARIABLES	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4	(5) Model 5	(6) Model 6
age	0.048***	0.048***	0.045***	0.045***	0.044***	0.044***
	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)
agesq	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
tenure	0.030***	0.030***	0.023***	0.023***	0.022***	0.023***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
tenuresq	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
union	0.134***	0.136***	0.071***	0.073***	0.075***	0.076***
	(0.012)	(0.012)	(0.013)	(0.013)	(0.013)	(0.013)
1.male	0.390***	0.388***	0.408***	0.406***	0.407***	0.406***
	(0.009)	(0.009)	(0.010)	(0.010)	(0.010)	(0.009)
1.permregular	0.401***	0.402***	0.308***	0.309***	0.309***	0.309***
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
2.edu_skill	0.186***	0.181***	0.117***	0.101***	0.117***	0.100***
	(0.017)	(0.020)	(0.017)	(0.019)	(0.017)	(0.019)
3.edu_ skill	0.441***	0.415***	0.266***	0.232***	0.266***	0.231***
	(0.020)	(0.022)	(0.020)	(0.022)	(0.020)	(0.022)
1b.edu_ skill#c.gvcforward_lag1		-1.272		-3.371**		-3.515**
		(1.763)		(1.662)		(1.658)
2.edu_ skill#c.gvcforward_lag1		0.230		0.028		-0.031
		(0.492)		(0.478)		(0.481)
3.edu_skill#c.gvcforward_lag1		3.476***		2.499***		2.424***
		(0.763)		(0.692)		(0.679)
gvcforward_lag1	1.175***		0.693*		0.623	
	(0.409)		(0.394)		(0.395)	
1.married			0.060***	0.060***	0.059***	0.059***
			(0.010)	(0.010)	(0.010)	(0.010)
2.firmsize			0.109***	0.110***	0.109***	0.109***
			(0.010)	(0.010)	(0.010)	(0.010)
3.firmsize			0.235***	0.234***	0.231***	0.230***
			(0.010)	(0.010)	(0.010)	(0.010)
Constant	3.312***	3.326***	3.464***	3.487***	3.478***	3.502***
	(0.065)	(0.065)	(0.067)	(0.068)	(0.067)	(0.068)
Observations	36,672	36,672	30,973	30,973	30,973	30,973
R-squared	0.551	0.552	0.591	0.592	0.595	0.595
Year FE	YES	YES	YES	YES	YES	YES
Region Dummies	NO	NO	NO	NO	YES	YES
Occupation Dummies	NO	NO	YES	YES	YES	YES
Individual FE	NO	NO	NO	NO	NO	NO
SE of regression	0.406	0.405	0.380	0.380	0.379	0.378
Adj. R-Squared	0.551	0.552	0.591	0.591	0.594	0.595

Notes:
(i) FE short for fixed effects
(ii) Cluster-robust standard errors in parentheses
(iii) *** p<0.01, ** p<0.05, * p<0.1
(iv) Re-parameterized interaction effects

Lagged Backward GVC Participation

TABLE 4.8 FIXED-EFFECTS LOG WAGE REGRESSION ON 1-YEAR LAGGED BACKWARD GVC PARTICIPATION

VARIABLES	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4	(5) Model 5	(6) Model 6
age	0.048***	0.048***	0.045***	0.045***	0.044***	0.044***
	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)
agesq	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
tenure	0.030***	0.030***	0.023***	0.023***	0.022***	0.022***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
tenuresq	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
union	0.129***	0.131***	0.071***	0.071***	0.075***	0.075***
	(0.012)	(0.012)	(0.013)	(0.013)	(0.013)	(0.013)
1.male	0.385***	0.385***	0.407***	0.406***	0.406***	0.406***
	(0.009)	(0.009)	(0.010)	(0.010)	(0.010)	(0.010)
1.permregular	0.396***	0.397***	0.307***	0.307***	0.308***	0.308***
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
2.edu_skill	0.187***	0.188***	0.117***	0.111***	0.117***	0.111***
	(0.017)	(0.019)	(0.017)	(0.018)	(0.017)	(0.018)
3.edu_skill	0.445***	0.439***	0.267***	0.261***	0.266***	0.260***
	(0.020)	(0.021)	(0.020)	(0.021)	(0.020)	(0.021)
1b.edu_skill#c.gvcbackward_lag1		1.034		0.053		0.027
		(0.972)		(0.850)		(0.861)
2.edu_skill#c.gvcbackward_lag1		0.991***		0.804***		0.747***
		(0.253)		(0.229)		(0.229)
3.edu_skill#c.gvcbackward_lag1		1.744***		0.840***		0.796***
		(0.367)		(0.313)		(0.305)
gvcbackward_lag1	1.250***		0.779***		0.728***	
	(0.207)		(0.184)		(0.183)	
1.married			0.060***	0.060***	0.059***	0.059***
			(0.010)	(0.010)	(0.010)	(0.010)
2.firmsize			0.106***	0.106***	0.105***	0.105***
			(0.011)	(0.011)	(0.010)	(0.010)
3.firmsize			0.232***	0.232***	0.228***	0.228***
			(0.010)	(0.010)	(0.010)	(0.010)
Constant	3.311***	3.313***	3.460***	3.466***	3.475***	3.480***
	(0.065)	(0.065)	(0.067)	(0.068)	(0.067)	(0.068)
Observations	36,672	36,672	30,973	30,973	30,973	30,973
R-squared	0.552	0.552	0.592	0.592	0.595	0.595
Year FE	YES	YES	YES	YES	YES	YES
Region Dummies	NO	NO	NO	NO	YES	YES
Occupation Dummies	NO	NO	YES	YES	YES	YES
Individual FE	NO	NO	NO	NO	NO	NO
SE of regression	0.405	0.405	0.380	0.380	0.378	0.378
Adj. R-Squared	0.552	0.552	0.591	0.591	0.595	0.595

Notes:
(i) FE short for fixed effects
(ii) Cluster-robust standard errors in parentheses
(iii) *** p<0.01, ** p<0.05, * p<0.1
(iv) Re-parameterized interaction effects

Overall, the skill-biased effect of total and forward participation remains robust to the time lags. In particular, the negative impact on wages for model 6 in forward participation, which adds region and occupation dummies as well as controls for firm size to the main specification shows an even stronger effect than the original models with no time lags. A 0.01 unit increase of domestic value added embodied in foreign exports to third countries is associated with about a 3.5% reduction in the wages of low-skilled workers and a 2.4% increase in the wages of high-skilled workers, while the effect on medium-skilled workers is ambiguous, perhaps due to offsetting productivity and labor supply or substitution effects. The estimates are respectively significant at the 5% and 1% level. Total participation also continues to show a skill-biased effect favoring high-skilled workers, although there are no significantly negative impacts on low-skilled workers (in contrast with forward participation.)

In contrast, after using 1 year lags, backward GVC Participation shows slight evidence of a skill-bias (although it is still very weak compared to total and forward participation). Increases in foreign value added in exports at the industry level generally lead to slightly steeper slopes for the wages of high-skilled workers compared to medium or low-skilled workers, although again, low-skilled labor's coefficient does not show any significant negative impact in contrast with the effects of forward supply chain trade. This may be due to improvement of estimation due to more observations, since lags allow 1 more year of observations for KLIPS data matched with OECD TiVA data (2009-2015 vs. 2009-2016). Another potential reason would be that GVC trade may take some time to

have a causal impact on wages. In any case, all three time lagged variables show overall consistent results in terms of magnitude, direction, and significance of coefficients.[101]

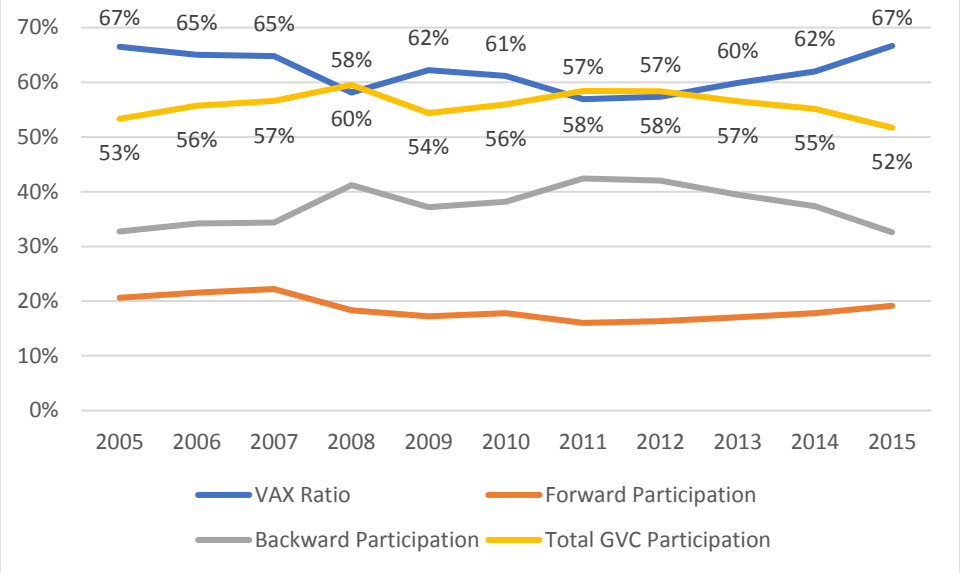
Hypothesis 3c *stating that time lagged GVC trade variables should show consistent results is supported, strengthening the robustness of hypothesis 1a, 1b, 1c, 2a, 2b, and 2c.*

[101] 2-year lagged variables also showed relatively consistent results. They are not included in the thesis to save space.

2.5. Alternative Specifications: Value Added Export (VAX) Ratio

The aggregate Value Added to Export (VAX) ratio is an inverse measure of GVC participation, since it measures the ratio of domestic value added embodied in foreign final demand over gross exports. In other words, more foreign content in exports would correspond with a lower VAX ratio.

FIGURE 2.28 VALUE ADDED EXPORT RATIO VS. GVC PARTICIPATION, KOREA 2005-2015



Source: Author's calculation using OECD TiVA data, December 2018 version

As shown in the graph from the earlier chapter on Korea's GVC participation, the aggregate VAX ratio of Korea is highly correlated with total GVC participation, showing an approximately inverse relationship. When looking at the overall, aggregate economy level, the VAX ratio has some advantages over the backward, forward, and total GVC participation indices used in the main empirical analyses.

One of the key differences is *sensitivity* to the number of production stages, or the *complexity* of the global value chain.[102] To give a comparison, the backward GVC participation index adds value-added from all stages and stays the same whether value is added one stage further or two or three, while the VAX ratio being based on the difference between gross trade (with double counting) and value-added trade (without double counting) is sensitive to the number of production stages (the more the production is fragmented the higher the difference and the lower the ratio). In short, the VAX ratio is more influenced by the number of production stages than the foreign value added in exports (backward supply chain trade). For example, if Samsung Electronics sources 25% of its inputs to make semiconductors from one supplier in Japan (which produced everything domestically), its backward GVC ratio would equal 25%, sourced in a very short international supply chain. If the same Japanese company were to source raw materials from China, Korea, and Saudi Arabia to make those inputs, or in other words if this supplier also uses inputs from other countries, total foreign value-added in exports would still equal to 25% but be part of a longer, more complex value chain involving many cross-border transactions. The backward participation would remain the same, but the VAX ratio should be higher in the second case of complex supply chains.[103]

At the same time, however, there is an important limitation of the *sector*-level

[102] The network diagrams by Li *et al.* (2019:29) & Meng *et al.* (2018), which I included to show Korea's role as a GVC hub were divided into simple versus complex global supply chains

[103] The author thanks Sebastien Miroudot of the OECD for bringing this to light

VAX ratio compared to the backward and forward vertical specialization indicators. This mostly stems from the difference between the Aggregate Level VAX Ratio and the Sector Level VAX Ratio. Contrary to the aggregate indicators, variation among different industry-level bilateral VAX ratios can be determined by factors other than the degree of global value chain participation (Johnson and Noguera, 2012). Johnson and Noguera (2012) state that cross-sector differences between industry VAX ratios are largely due to whether sectors engage *directly* or *indirectly* in trade, as well as industry-specific production characteristics in how much value added is generated relative to output (the value added to output ratio). This means that the industry-level VAX ratios are not clear measures of domestic value added embodied in foreign final demand to gross exports, contrary to the aggregate ratio, which was highly correlated with total GVC participation.

To illustrate, at the industry-level, VAX ratios between agriculture, for instance, and electronics manufacturing may be different simply due to differences in how much value added is created relative to production output, or more importantly, due to whether a sector participates indirectly in GVCs or directly in GVCs, rather than the degree of vertical specialization (Johnson and Noguera, 2012). Sectors such as agriculture can have high VAX ratios above 1 but still have high levels of GVC participation if they indirectly export through other industries (such as food processing manufacturing). As Chung (2015) explains, industry-level VAX ratios could hypothetically even reach infinity if there are no actual gross exports but only indirect exports – for instance, if agriculture were used as inputs in manufacturing exports, but no agricultural products

were directly exported). Thus, it would be misleading to think at the sector level that only lower VAX ratios correspond to more GVC participation, which is different from the interpretation of VAX ratios at the aggregate economy level. This is one of the main reasons that this study used the sector-level total, forward, and backward GVC participation indices instead of the VAX ratio. Nevertheless, this research argues that in spite of the aforementioned problems of interpreting industry-level VAX ratios as a measure of GVC participation, if confined to manufacturing, changes in the VAX ratios over a few years are less likely to be due to changes in industry characteristics such as the value added to output ratio. Constraining to manufacturing industries is also more likely to measure the degree of GVC participation in a more consistent way (the lower the VAX ratio, the higher the GVC participation observed) since unlike services or agriculture, the majority of manufacturing industries are less likely to participate more through indirect value-added trade relative to directly exporting value-added. An observation of the VAX ratios calculated in this study showed that all of the manufacturing sectors maintain ratios less than 1 over the years, with the only exception being the wood processing / paper industries. Thus, although relying on less accurate logic, sector-level VAX ratios for manufacturing industries are used as robustness checks for the GVC indices.

Again, whereas the coefficient $\boldsymbol{\lambda}$ for the interaction term $\boldsymbol{\lambda} * \boldsymbol{GVCP_{jt}} * \boldsymbol{EDUC_{it}}$ was expected to be positive ($\boldsymbol{\lambda} > 0$) for the GVC participation indices, since *lower* sector-level VAX ratios correlate with more international fragmentation of

production (but less so than aggregate VAX ratio as explained in detail above), the expectation is that the interaction terms should show negative ($\boldsymbol{\lambda} < 0$) coefficients, with stronger negative coefficients for high-skilled workers than low-skilled workers. In other words, higher VAX ratios correspond to **less** GVC Participation, so the expectation is *lower* wages as VAX gets *higher* (negative effect). Furthermore, coefficients for high skilled workers should have *larger negative* values than lower skilled workers.

Value Added to Exports Ratios, Manufacturing Only

TABLE 4.9 FIXED-EFFECTS LOG WAGE REGRESSION ON MANUFACTURING VAX RATIOS

VARIABLES	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4	(5) Model 5	(6) Model 6
age	0.042***	0.043***	0.035***	0.035***	0.035***	0.035***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
agesq	-0.001***	-0.001***	-0.000***	-0.000***	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
tenure	0.027***	0.026***	0.018***	0.018***	0.019***	0.019***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
tenuresq	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
union	0.186***	0.188***	0.079***	0.080***	0.077***	0.079***
	(0.020)	(0.020)	(0.019)	(0.019)	(0.019)	(0.019)
1.male	0.442***	0.441***	0.439***	0.438***	0.429***	0.429***
	(0.020)	(0.020)	(0.018)	(0.018)	(0.018)	(0.018)
1.permregular	0.305***	0.305***	0.257***	0.257***	0.261***	0.261***
	(0.029)	(0.029)	(0.028)	(0.028)	(0.027)	(0.027)
2.edu_skill	0.167***	0.196***	0.115***	0.140***	0.110***	0.122***
	(0.033)	(0.051)	(0.031)	(0.048)	(0.030)	(0.047)
3.edu_skill	0.434***	0.536***	0.215***	0.269***	0.214***	0.256***
	(0.038)	(0.063)	(0.036)	(0.058)	(0.036)	(0.057)
VAX Ratio	-0.129***		-0.074***		-0.055***	
	(0.025)		(0.021)		(0.020)	
edu_lowskill(base)#c.vax		-0.075		-0.035		-0.034
		(0.052)		(0.049)		(0.050)
edu_midskill#c.vax		-0.120***		-0.074***		-0.052**
		(0.029)		(0.024)		(0.024)
edu_highskill#c.vax		-0.263***		-0.130**		-0.111**
		(0.063)		(0.055)		(0.054)
1.married			0.109***	0.110***	0.097***	0.098***
			(0.017)	(0.017)	(0.017)	(0.017)
2.firmsize			0.103***	0.103***	0.105***	0.105***
			(0.015)	(0.015)	(0.015)	(0.015)
3.firmsize			0.283***	0.282***	0.274***	0.273***
			(0.017)	(0.017)	(0.017)	(0.017)
Constant	3.600***	3.562***	3.732***	3.707***	3.733***	3.719***
	(0.135)	(0.139)	(0.127)	(0.130)	(0.126)	(0.129)
Observations	7,726	7,726	7,497	7,497	7,497	7,497
R-squared	0.585	0.586	0.651	0.651	0.660	0.660
Year FE	YES	YES	YES	YES	YES	YES
Region Dummies	NO	NO	NO	NO	YES	YES
Occupation Dummies	NO	NO	YES	YES	YES	YES
SE of regression	0.352	0.352	0.319	0.319	0.315	0.315
Adj. R-Squared	0.585	0.585	0.649	0.650	0.658	0.658

Notes:
(i) FE short for fixed effects
(ii) Cluster-robust standard errors in parentheses
(iii) *** p<0.01, ** p<0.05, * p<0.1
(iv) Re-parameterized interaction effects

The regression output supports ***hypothesis 3a*** that "*a lower sector-level value added export (VAX) ratio correlates with higher wages*." In the main specification, a 1 unit increase in the VAX ratio for manufacturing industries corresponds to approximately a 13% decrease in wages. Although the magnitude decreases, this inverse relationship continues to be statistically significant at the 1% level in alternative specifications with more fixed effects and other controls. Furthermore, ***hypothesis 3b*****,** which expects "***a skill-biased impact of more production fragmentation indirectly measured through lower VAX ratios***" is also supported. In the main specification model 2, a 1 unit increase in the sector-level VAX ratio is associated with roughly 12% lower wages for medium skilled workers and 26.3% lower wages for high skilled workers, both coefficients being statistically significant at the 1% level. Similar results are shown in the alternative models with more controls. Although not directly presented in the thesis, 1 year time lags also showed similar results.

Value Added to Exports Ratios, All Industries

TABLE 4.10 FIXED-EFFECTS LOG WAGE REGRESSION ON VALUE ADDED EXPORT RATIOS FOR ALL INDUSTRIES

Fixed-effects log wage regression on Sector-Level VAX Ratios for ALL Industries

VARIABLES	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4	(5) Model 5	(6) Model 6
vax	0.000		0.000		0.000	
	(0.000)		(0.000)		(0.000)	
1b.edu_skill#c.vax		0.000		0.001*		0.001*
		(0.000)		(0.001)		(0.000)
2.edu_skill#c.vax		0.000**		0.000		0.000
		(0.000)		(0.000)		(0.000)
3.edu_skill#c.vax		0.000		0.000		0.000
		(0.000)		(0.000)		(0.000)
1.married			0.061***	0.061***	0.060***	0.060***
			(0.010)	(0.010)	(0.010)	(0.010)
2.firmsize			0.105***	0.105***	0.103***	0.103***
			(0.011)	(0.011)	(0.011)	(0.011)
3.firmsize			0.237***	0.237***	0.232***	0.232***
			(0.011)	(0.011)	(0.011)	(0.011)
Constant	3.311***	3.311***	3.465***	3.463***	3.478***	3.475***
	(0.069)	(0.069)	(0.071)	(0.071)	(0.071)	(0.071)
Number of clusters	7,661	7,661	7,055	7,055	7,055	7,055
Observations	31,824	31,824	26,935	26,935	26,935	26,935
All Other Controls	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Region Dummies	NO	NO	NO	NO	YES	YES
Occupation Dummies	NO	NO	YES	YES	YES	YES
Individual FE	NO	NO	NO	NO	NO	NO
SE of regression	0.406	0.406	0.380	0.380	0.379	0.379
Adj. R-Squared	0.548	0.548	0.588	0.588	0.592	0.592

Notes:
(i) FE short for fixed effects
(ii) Cluster-robust standard errors in parentheses
(iii) *** p<0.01, ** p<0.05, * p<0.1
(iv) Re-parameterized interaction effects
(v) "All Other Controls" in previous regression tables included

On the other hand, contrary to the total, backward, and forward GVC trade measures, the sector-level VAX ratio does now show any evidence of a boost to wages for workers of all skill categories, nor a skill-biased effect, if the sample is not constrained to manufacturing workers. The coefficients of both the main effects and interaction effects are effectively zero and mostly insignificant. Nevertheless, there is not much reason to

be taken by surprise. As explained earlier, the differences in agriculture, service, and manufacturing sector VAX ratios are mostly determined by whether the industries *directly* or *indirectly* participate in GVC trade. Agriculture and service sectors may show increasingly higher and positive VAX ratios above 1 as they indirectly participate in GVC trade, which would offset the negative direction of fragmentation of production in manufacturing. The lack of statistically significant results for sector-level VAX ratios on all industries is thus no reason to reject any of the main hypotheses of this research. In any case, in terms of causation between wages and GVC trade, it is logical that importing and exporting to foreign firms and customers matters more for productivity than being in a short or long international supply chain. The former would be adequately measured by the total, forward, and backward GVC ratios, without relying on the sector level VAX ratios.

Overall, the skill-biased impact of global value chain participation remained robust to many alternative specifications including different types of GVC participation (although less so for backward participation), additional lagged variables, and manufacturing sector VAX ratios. Although not presented in this paper, separate sub-group regressions by skill level that relax the assumption of equal slopes on control variables also showed evidence of a skill bias.

TABLE 4.11: SUMMARY OF EMPIRICAL FINDINGS

Hypothesis	Description	Empirical Result
1a	There is a positive association between the skill level of individual workers (measured by educational attainment) and their average monthly wages, i.e. there exists a wage premium on education.	**Supported**
1b	There is a positive correlation between the degree of ***total*** participation in global value chains at the industry level and the average monthly wages of labor working in those industries that are more integrated into GVCs.	**Supported**
1c	The boost in wages caused by deeper GVC integration at the industry level is larger for high skilled workers than workers with lower levels of educational attainment. In other words, ***total*** global value chain participation has a bias favoring high-skilled labor.	**Supported**
2a	***Backward*** GVC participation would also boost productivity and thus overall wages, but its skill-biased effect would be weakest	Partially Supported
2b	The skill-biased effect of ***forward*** GVC participation is strongest (the boost in wages caused by deeper forward linkages at the industry level is *very* large for high skilled workers compared to lower-skilled workers)	**Supported**
3a	A lower sector-level value added export (VAX) ratio correlates with higher wages (moves in opposite direction of GVC indices)	**Supported**
3b	There is a skill-biased impact of more production fragmentation indirectly measured through lower ***VAX ratios*** (evidence only for manufacturing industries)	Partially Supported
3c	Time lagged GVC trade variables should show consistent results	**Supported**

Notes: *Hypotheses construction based on qualitative characteristics of Korea's GVC trade*

V. CONCLUSION

1. Contribution to Existing Literature in Economics

This study found clear empirical evidence that in Korea, exposure to globalization in the form of increased global value chain participation has had a favorable impact on the wages of high skilled workers as opposed to low or middle skilled labor. The expansion of global value chains means that conventional gross trade may be inadequate for properly analyzing the effect of trade on labor markets – GVC trade in intermediate goods and services now accounts for about 70% of world trade. Although empirical studies have been conducted on the effects of offshoring and certain parts of supply chain trade since the late 1990s, studies using the most recent form of the Global Value Chain Participation Index are scant, and only one previous study exists in Korea examining individual level data with the industry level data of the total GVC participation index. These GVC trade indices provide a much fuller picture of international fragmentation of production as compared to previous first-generation statistics. Moreover, one of the important advancements in this research compared to the existing literature[104] on the effect of GVC participation on workers in Korea is that the labor market impacts of three different types of GVC participation are separately analyzed: total, backward, and

[104] Choi *et al.* (2015) *Global value chains and workforce policy* (published in Korean, 2015) and the English summary, "Global Value Chains and the Skill-biased Effects on Wages in Korea" *KIET Industrial Economic Review* Jan. / Feb. 2016 Vol 21 No 1

forward.

López-González *et al.* (2015) suggested that the effect of GVC participation on wage-income inequality can differ depending on whether it is total, backward, or forward GVC participation, with backward participation correlating with less inequality and forward participation associated with slightly more inequality. In contrast, Farole *et al.* (2018) found that backward GVC trade, or the foreign value added share of gross exports is skill-biased, favoring high-skilled workers, while generally forward supply chain trade as measured by domestic value added embodied in exports to third countries generally showed statistically insignificant results. This thesis found empirical evidence to support the findings of López-González *et al.* (2015), although a key difference is that this study is focused on a specific country rather than doing a cross-country comparison.

The impact of cross-border supply chain trade in intermediate inputs and offshoring on labor markets was shown to have ambiguous effects on wages and employment both theoretically and empirically, with different results depending on the assumptions and data used, as well as qualitative factors such as the type of offshored skills and tasks, and the relative strength of the productivity, labor supply, and relative price effects. In the context of analyzing vertical specialization, this thesis highlighted the fact that even value added trade data is inadequate for assessing the direction of industrial upgrading, as moving to higher value added business functions along the smile curve could mean both less foreign value added in exports or more, depending on the stage of a country's development as well as unique industry characteristics. This means

that the composition of both backward and forward participation can differ considerably among countries. For instance, Saudi Arabia's forward supply chain trade to Korea consists of mostly raw materials or energy exports, Japan mostly high-tech or sophisticated inputs, and China relatively low-skill-intensive inputs. This thesis thus demonstrated that such country-specific heterogeneity among GVC indicators may be another key reason that the labor market impacts of GVC trade have shown conflicting results in cross-country studies.

Based on these observations, much effort was put in understanding the unique qualitative composition of skills, tasks, and business functions in the context of Korea's stage of development and composition of exports. The thesis found evidence that Korea's forward GVC participation (such as semiconductors or OLED displays to assembly platforms such as China, Vietnam, and Mexico) should embody an increasing number of sophisticated R&D and other high-skill-intensive activities offshored to Korea, while backward supply chain trade consists of primary products, sophisticated inputs, and many non-sophisticated intermediate goods and services. These qualitative findings underpinned the main hypotheses that Korea's forward GVC trade should be skill-biased, while there should be more ambiguous effects of backward participation on Korea's labor market. Overall, the following quantitative analyses testing the hypotheses provided at least partial and mostly strong support for all of the hypotheses. Much attention was paid to ensure methodological robustness, with the inclusion of many important control variables, fixed effects, and alternative specifications. The overall

research design of linking industry-level trade data with wages of individual workers was shown to improve robustness to endogeneity problems coming from simultaneous bias, and caution was used in selecting the most recent updated trade in value added data as well as Korea's only longitudinal individual labor data. Furthermore, variables such as educational attainment were adjusted to properly reflect Korea's labor market characteristics, as changes in skill definitions were shown to impact the existence of a skill-biased effect. With a reasonable level of confidence, the fixed effects panel regressions on total, forward, and backward GVC participation supported the expected hypotheses on how workers of different skill categories would be subject to skill-biased effects on wages. Moreover, in an additional round of robustness checks, the sector-level VAX ratio was also shown, at least for manufacturing industries, to show a skill-biased impact on wages favoring high-skilled workers, in spite of its limits as a measure of GVC participation.

To the best of the author's knowledge, this thesis may be the first empirical study to combine individual panel data on both males and females with the three types of GVC participation indices for all industries (including agriculture and services) and find evidence of a skill-bias. Aside from finding heterogeneous distributional effects of different types of vertical specialization, this study demonstrated that all forms of GVC trade have overall positive impacts on wages at the micro-level, which supports the view that protectionist trade policies or export restrictions would mean forgoing the benefits of more globalization of production that accrue from international supply chains. The

years examined were immediately after the global financial crisis, a period when GVC expansion slowed (Nagengast and Stehrer, 2016). Since the impacts of offshoring and GVC trade on inequality have been shown to change depending on the years examined (Feenstra, 2016), this study further contributes to the empirical literature by examining an important new period for GVC studies.

2. Contribution to Policy-Making and Other Academic Fields

At a more multidisciplinary level, although there are limitations to generalizing the short-run wage effects observed in this micro-level data to the overall economy level, the study has shown evidence that a skill-biased impact on wages may potentially contribute to income inequality. This should be of interest to scholars in sociology and political science as well, considering that a dilemma may exist where GVC participation may cause populist pressure for protectionism and hinder democratic institutions, even though that would be detrimental for aggregate economic well-being. Moreover, if the spread of global value chains is a contributing factor to backlashes against globalization, the current world order based on liberal trade policy and capitalism may be threatened. Cooperation among nations is based largely on accumulated trust, and the recent trade wars among the world's largest economies are not conducive to the effective functioning of international trade and production. The offsetting effects of domestic protectionist backlashes leading to less cooperative behavior under GVCs and the simultaneous increase in international linkages and dependency among national economies should thus be of interest to researchers in international relations or political economy as well.

Meanwhile, a rapid expansion of the tertiary labor force in Korea has also not been successful in eliminating inequality, meaning that increasing the supply of high-skilled labor as measured through educational attainment may not be the best solution. The increase in 2 year and 4 year university graduates seems to have led partly to more differentiation among the top universities and labor market mismatches between demand and supply for certain skills, with a growing attention to the so-called "academic inflation" effect. Rather, ensuring labor supply of skills most needed in the market may alleviate skill-biased effects. In light of the fact that Korea's forward GVC trade seems to be associated with industrial upgrading into higher value added functions such as R&D, restructuring the education system to ensure that the most demanded skills are supplied seems to be the best solution, as opposed to simply supplying increasing numbers of students graduating from colleges. Meanwhile, studies have shown correlations between higher preference for liberal trade policies and education to economic information as opposed to just distributional impacts, suggesting that there may be a role for education in reducing protectionist policies (Hainmueller and Hiscox, 2006).

3. Limitations and Suggestions for Future Research

There are nevertheless some limitations to this thesis which may be better addressed in further research. The earlier advantage in studying new periods less examined in the empirical literature can also be a disadvantage if the goal is to find generalizable results for all time frames. Furthermore, the GVC participation indices

constructed for this research were based on Korea's value added trade with the rest of the world, not a particular country or region. Earlier studies on offshoring, trade, or FDI have shown that the bilateral partner in question can have a significant impact on whether there is a positive or negative impact on employment and/or wages. Korea's forward participation to China may differ from its participation with the US, likewise, Korea sourcing primary imports of oil from the middle east can be different from backward participation in sourcing inputs from Japan. The lack of trade statistics in *business functions or tasks* further compounds these problems. Thus, further insights may be found from addressing regional heterogeneity in GVC participation, although this study has supplemented the general hypotheses on Korea's regional composition of GVC trade by qualitative analysis.

Moreover, the dependent variable in this study is the average individual workers' wage at the micro level. Other labor market effects such as unemployment and wealth transfers are unobservable, and the study does not directly measure inequality (Geishecker and Görg, 2008; López-González *et al.*, 2015:18). Nevertheless, the OECD (2011:22) and López-González *et al.*, (2015:19) suggest strong causal linkages between wages and income inequality, since wages comprise on average 3 quarters of household income among working adults. Moreover, the theoretical trade models such as Grossman and Rossi-Hansberg (2008) are largely linked with wage effects based on trade in value added, so the dependent variable as wages should not by itself be seen as a considerable problem (López-González *et al.*, 2015:19).

Another issue relates to cross-country comparability. In order to properly address the issue of academic inflation in Korea (and infer the proper relative supply of high-skilled workers with respect to low or mid-skilled workers), the educational attainment levels were categorized differently from the global ISCED standard. The empirical results using the ISCED standard showed no evidence of a skill bias, meaning that it may be difficult to compare these results with other countries. Nevertheless, this could also be viewed as a strength of the study, since using international classifications would lead to misleading conclusions on the distributional impact of GVC trade on Korea. In a different note, Grundke *et al.* (2017) stated that using country-specific information on educational attainment or occupation status of jobs cannot adequately proxy skills, since workers with the same education level or occupation still show considerable differences in wages. Using cognitive skills such as literacy, numeracy and problem solving as they did would provide new insights, but most available data (including KLIPS) does not provide such proxies of skills.

In a similar context, difficulties may arise in comparing different economies due to heterogeneous institutions. Differences in legal, institutional, and labor market systems can change comparative advantage and distributional impacts among different countries, as well as both the quantitative and qualitative nature of each country and sectors' GVC participation (Dollar and Kidder, 2017:162; Geishecker, Görg, and Munch, 2010; Hall and Soskice, 2001). For instance, Dollar and Kidder state that the strong legal system of the U.S. supports contract enforcement and enhances comparative advantage

of business services (2017:164). This may bring heterogeneous results on whether forward or backward participation have skill-biased effects or not, as it can change the composition of skills and technology embodied within the supply chain trade. Nevertheless, this should be less of a problem for this country-specific study compared to cross-country studies, as it better accounts for the unique characteristics of Korea's economic, educational, and industrial systems.

Finally, the study assumes that skill-biased technological change can be a key mechanism through how GVC participation affects wage differences, since GVC participation may assist industrial upgrading, or specialization in high-skilled tasks in the value chain. Moreover, cross-sectional differences *across* industries in GVC trade are also important sources of variation in the degree of GVC participation. As a result, industry and industry-time fixed effects are not used, although year fixed effects control for some of the overall changes in technological developments. In any case, this study does not clearly differentiate the effects of GVC participation from skill-biased technical change. This study can hopefully serve as a starting point for more empirical research that can address these methodological issues, although the thesis has also underscored in the main text that in an age of GVCs, there is no longer a key distinction between skill-biased technical change, automation, and trade, with all factors increasingly intertwined together.

To sum, this thesis has shown clear evidence of a skill-biased distributional impact of GVC trade, particularly forward participation, which is contrary to the findings

of many other empirical studies. Wages of high-skilled workers were shown to increase at faster rates than labor with less educational attainment. Although there could be some limitations in linking the micro-level wage effects with aggregate economy outcomes of income inequality, the methodological robustness of the study at least supports a strong causal effect between different types of vertical specialization and heterogeneous labor market outcomes. This suggests that the backlash against globalization in many countries is to some degree understandable. However, this thesis demonstrated that all types of GVC participation also contribute to rising overall wages. Even backward participation, which implies more imported foreign value added in gross exports and lower shares of domestic value added, was shown to increase wages. Thus, considering the significant role of trade in global value chains in improving the overall prosperity of workers today's world economy, protectionist policies are likely to negatively affect the very people they are intended to "protect." Various policy efforts should therefore be made to ensure that the gains from GVC trade and growth are more inclusive, in order for a continuation of the liberal trade system which has contributed to maintaining peace and global prosperity

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국문초록

글로벌 가치사슬 참여가 한국 노동자의 임금에 차별적으로 미치는 숙련편향적 효과: 부가가치 무역과 KLIPS 패널 데이터 기반의 실증 분석

본 연구의 목적은 글로벌 가치사슬 (global value chain, GVC), 혹은 여러 국가에 걸친 생산 단계의 분화 과정에 참여하여 특정 형태의 중간재 무역이 증가할 때, 숙련도가 다른 한국 노동자들의 임금에 차별적인 영향이 발생하는 가의 여부를 실증적 분석을 통해 검증하는 것이다.

최근 여러 개발도상국과 선진국에서 국가 내 불평등이 심화되는 현상이 관측되고 있으며, 이는 학계 및 정책입안자들 뿐만 아니라 일반인들의 주요 관심 대상이 되었다. 불평등이 정치적 안정성과 사회 통합에 영향을 미친다는 사실은 오랜 시간 인지되었다. 많은 국가 내에서 포퓰리즘과 시위가 늘어나는 등 정치적 갈등이 심화되고 있으며, 세계에서 경제 규모로 각각 1, 2위를 차지하는 미국과 중국 간의 무역 분쟁으로 현실화된 보호무역주의의 재등장은 오늘날 세계화와 불평등 사이의 상관 관계가 정치적으로 더욱 심각한 의의를 가진다는 것을 보여준다. 그러나 국제 생산 네트워크는 여러 국경을 넘나드는 글로벌 공급망 무역을 통해 촘촘하게 이어지는데, 이러한 글로벌 밸류 체인이 확산된 오늘날에는 관세, 쿼터, 그리고 기타 수입·수출 규제와 같은 비관세장벽의 비용이 더욱 높아졌다.

다시 말해 GVC 시대에서는 각 생산 단계를 거치며 수입 중간재가 국경을 여러 번 넘나들면서 관세의 비용이 누적·증폭되며, 전통적으로 내수형으로 여겨지는 농업과 서비스 같은 산업에 속한 생산과 고용 역시 해외시장에 의존하는 경향이 커지는데, 이는 내수형 산업들조차 직접적으로 수출되는 제조업품 속의 부가가치로 체화되어 간접적으로 부가가치를 수출하기 때문이다. 따라서 과거 시대에 비해 무역 장벽은 고용과 임금에 더욱 부정적인 영향을 미칠 수 있을 뿐만 아니라, 양자간 무역의 직접적인 당사자 뿐만 아니라 간접적으로 국제 공급 사슬 무역에 참여하는 수많은 관련 국가와 산업들 모두에게 영향을 미칠 수 있다. 따라서 현대 사회에서 보호무역의 비용이 유래없이 높아진 만큼, 과연 그러한 정책의 밑바탕이 된 불평등 문제가 정말 무역에서 비롯된 것인지 정밀하게 연구하는 것은 아주 중요한

문제라고 할 수 있다. 1980년대와 90년대 초반까지 주류 경제학자들의 전반적인 의견은 무역이 불평등에 미친 영향이 미미했으며, 고숙련·저숙련 노동자들의 임금 격차가 벌어진 데에는 숙련 편향적 기술 진보와 같은 다른 요인들이 훨씬 중대한 효과를 미쳤다는 것이었다. 그럼에도 불구하고 세계화와 불평등의 관계에 대한 정책 입안자들과 일부 학계의 염려는 계속되어 왔으며, 특히 해외 아웃소싱 혹은 오프쇼어링과 임금 불평등의 관계에 대한 최근의 경험적 연구들은 여러 상반되는 결과들을 도출하였다. 한편, 글로벌 밸류 체인과 생산의 파편화가 확산된 상황에서는 무역의 잠재적인 숙련 편향적 효과를 새로운 GVC와 부가가치 무역 지수들로 연구하는 것이 중요하다. 이는 리카르도나 애덤 스미스 시대처럼 수출 속 부가가치가 거의 100% 국내에서 생산되는 것이 아니라 해외에서 수입한 중간재 혹은 다른 투입 요소가 차지하는 해외창출 부가가치 비중이 매우 커졌기 때문이다. GVC참여가 노동시장의 소득 재분배에 미치는 영향에 대한 최신의 경험적 연구들 역시 서로 상충되는 결과들을 내놓은 점에서, 더욱 정교한 방법론으로 다듬어진 실증 분석의 필요성이 제기된다. 특히 국제 공급 사슬 무역 속에 체화된 기술과 노동은 전통적 무역 이상으로 산업 고도화나 추가적인 노동 수요와 공급의 이동을 유발할 수 있기 때문에, 같은 GVC무역이라도 산업 혹은 국가에 따라 다른 영향을 미칠 수가 있다.

글로벌 가치 사슬에 가장 활발하게 참여하는 국가 중 하나인 한국의 사례가 중요한 또다른 이유는, 많은 경제학자들이 대학교와 같은 고등 교육에 투자를 해서 고숙련 노동의 비중을 높이는 것이 고숙련·저숙련 노동자 간의 임금 불평등을 해소할 수 있는 효과적 방안으로 제시하고 있고, OECD에서 가장 높은 비율의 고숙련 노동자를 보유하고 있는 한국의 경우 대학교육 이수자의 지속적인 증가가 있었음에도 불구하고 임금 불평등이 해소되기는커녕 심화되었다는 점이다. 따라서 GVC와 임금 불평등의 구조를 연구하는 것은 GVC참여를 통해서 한국과 비슷한 방식으로 산업들의 기술 구조를 고도화하고자 하는 개발도상국들에게 좋은 참고가 될 수 있을 것이다. 한국의 예는 또한 선진국들에게도 중요한 의의를 가질 수 있다. 한국은 선진국 중에서 특이하게도 강건한 제조업 기반을 유지하고 있으며 반면에 서비스 산업이 상대적으로 낮은 비중을 차지하고 있다. 이런 산업 구조를 가지고 있음에도 GVC참여가 숙련 편향적인 효과를 보인다면, 최근 미국과 같은 선진국들이 보호무역을 통해 억지로 자국으로 (점점 낮은 부가가치를 차지하는) 생산·조립 단계 공정을 되돌리려는 “리쇼어링”을 유도하더라도 그

들이 원하는 불평등의 개선 효과가 없을 수도 있다는 점을 함의한다.

산업 구조, 국가의 위치와 규모 등 수많은 요인에 따라 GVC참여가 노동 시장에 미치는 영향이 상이할 수 있는 바, 본 연구는 최근 축적된 국제 생산 분업에 대한 전반적인 선행 연구 분석과 함께 한국의 오프쇼어링, GVC관련 무역, 해외직접투자, 그리고 개발 및 산업 고도화 등의 다방면적인 질적 특성을 살펴봄으로써 이질적인 여러 종류의 GVC참여 방식이 국내 노동자들의 숙련도에 따라 임금에 어떤 상이한 영향을 미칠 수 있는지에 대한 가설을 설정한다. 본격적인 양적 회귀분석에 앞서 질적인 분석을 겸하는 이유는 GVC 무역 내에 체화된 업무와 숙련도를 알아야 노동 시장에 미치는 영향을 보다 정확히 파악할 수 있는 상황 속에서, 현재의 부가가치기준 무역 데이터조차 가치사슬 내의 정확한 산업 고도화 방향과 직무의 구성을 알기 어렵기 때문이다.

연구 가설들을 검정하기 위해 먼저 한국고용노동패널데이터 (KLIPS)에서 추출한 7,689명의 개인과 총 31,974개의 관측치로 이루어진 표본을 구성한 후 2018년 발표된 가장 최신 형태의 경제협력개발기구 (OECD) – 세계무역기구 (WTO) 부가가치 기준 무역 (TiVA) 지표들을 병합한다. 이 실증 분석 모형은 2005년부터 2015년까지 64개국간의 부가가치 무역을 추정하는 TiVA의 36개 산업 수준 지표들을 2009년부터 2017년까지의 개인 수준의 한국 노동자 데이터와 연결한다. 교육 수준으로 측정된 노동의 숙련 수준을 각 노동자가 속한 산업의 세 종류의 GVC 참여 지수 (총 참여율, 전방 참여도, 후방 참여도)와 함께 교차항에 넣어 상호 작용 효과 존재 여부를 살펴본다. 실증 분석을 위해 우선 변형된 Mincer 형태의 임금 모형에 종속변수인 각 개인 수준의 임금과 핵심 독립 변수인 노동 숙련도와 GVC참여율로 구성된 교차항과 함께 다양한 통제 변수와 고정 효과를 넣은 후, 패널 회귀분석을 실시한다. 이처럼 산업 수준 GVC 무역 지표를 개인 수준 임금 데이터와 통합시키는 방법론은 산업 수준 GVC 교역 지수를 산업 수준 임금 데이터와 연결 지은 기존 선행 연구에 비해서 동시적 인과관계로 인해 발생할 수 있는 내생성 편의 문제를 어느 정도 통제할 수 있다는 점에서 상당한 이점을 가진다.

실증 분석 결과 전반적으로 산업 수준에서의 GVC참여가 여러 숙련도로 나뉜 개인 노동자 수준의 임금에 유의미한 차등적인 효과를 보이는 것으로 나타났다. 우선 교차항을 고려하지 않았을 때 전방, 후방 및 총 GVC

참여율 모두 다른 변수들을 통제했을 때에도 통계적으로 매우 유의미하게 임금을 높이는 것으로 보였다. 하지만 이와 동시에 GVC참여는 고숙련 노동자들에게 상대적으로 더욱 큰 긍정적 임금 효과를 주는 숙련 편향적 효과가 있는 것으로 나타났다. 여러 종류의 GVC참여 중에서도 전방 참여가 가장 큰 숙련 편향성을 나타내는 것을 드러냄으로써, 본 연구는 GVC참여의 종류를 구분하는 것이 매우 중요하다는 점을 확인하였다. 이는 한국의 노동 시장에 대한 선행 연구들이 거의 다루지 않은 부분일 뿐만 아니라, 최근에 세계 단위로 분석한 연구와 정 반대의 결과를 보여주기 때문에 기존 연구에 상당 부분 기여한다고 할 수 있다. 본 논문의 결과는 또한 동일한 형태의 GVC무역도 국가의 개별적 특성에 따라 체화된 숙련수준과 생산활동의 구성비에 따라 노동시장에 미치는 영향이 다를 수 있다는 점을 시사한다.

한편, 결과의 강건성 검증을 위해 다른 형태의 통제 변수와 모형, 그리고 대안적인 핵심 설명 변수로 시간 래그 변수와 총수출액 대비 부가가치 수출액의 비율(VAX Ratio)을 사용했을 때에도 전반적인 회귀 분석 결과는 유사하게 나오는 것으로 확인하였다. 본 연구는 한국의 경우 글로벌 공급사슬 무역에 참여하는 것이 적어도 미시적인 수준에서 노동 시장에 숙련 편향적인 효과를 가져온다는 것을 밝히면서도, 동시에 모든 종류의 GVC참여가 노동자들의 전반적인 임금 수준에 긍정적인 영향을 미친다는 점을 보여줌으로써, 최근 불평등을 해소하는 정책으로 확산되는 보호무역주의는 최적의 해결책이 아니라는 경제학의 관점을 경험적 분석을 통해 확인하였다. 본 논문에서 무역과 노동 경제학이 가장 많은 부분을 차지하지만, GVC와 관련된 연구가 여러 학제간 교류가 활발한 간학문적인 분야라는 점과 최근의 무역 전쟁 및 불평등 문제가 정책적으로도 중대한 사안인만큼, 본 연구에 포함된 여러가지 이론 및 실증 분석의 결과들은 정치학, 국제관계학, 정치경제학, 사회학, 교육학, 행정학, 그리고 경영학과 같은 다양한 분야의 연구자들에게 유용한 결과를 제시한다.

주제어: 글로벌 가치사슬; 국제 부가가치 무역; 오프쇼어링; 노동 시장 임금 불평등; 패널 데이터 분석; 숙련도와 교육 프리미엄; 수직적 분업

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